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A Taxonomic Revision of the Genus *Plagiothecium* for North America, North of Mexico

by Robert R. Ireland

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A TAXONOMIC REVISION OF THE GENUS *PLAGIOTHECIUM* FOR NORTH AMERICA, NORTH OF MEXICO

By Robert R. Ireland

Ottawa 1969

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Résumé

Cette révision du genre *Plagiothecium* (Mousses) en Amérique du Nord, au nord du Mexique, fait suite à la dernière révision, effectuée en 1932 par Grout. L'étude a permis d'examiner plus de 4,000 spécimens d'herbier et d'observer et cueillir des spécimens de la plupart des taxa dans de nombreux endroits d'Amérique du Nord. Un comptage des chromosomes a été fait sur des échantillons provenant de 25 groupes des États de Washington et d'Idaho, représentant cinq espèces, dont deux n'avaient pas encore été comptées.

La révision reconnaît 18 espèces pour l'Amérique du Nord, au nord du Mexique. Les genres *Isopterygium*, *Taxiphyllum* et *Sharpiella* (*Dolichotheca*) sont séparés du genre *Plagiothecium*. Sont reconnues les espèces suivantes: *Plagiothecium denticulatum* (Hedw.) B.S.G., *P. laetum* B.S.G., *P. latebricolum* B.S.G., *P. piliferum* (Hartm.) B.S.G., *P. roeseanum* B.S.G. et *P. undulatum* (Hedw.) B.S.G.; *Isopterygium distichaceum* (Mitt.) Jaeg. et Sauerb., *I. elegans* (Brid.) Lindb., *I. muellerianum* (Schimp.) Jaeg. et Sauerb., *I. pulchellum* (Hedw.) Jaeg. et Sauerb. et *I. tenerum* (Sw.) Mitt.; *Taxiphyllum alternans* (Card.) Iwats., *T. cuspidifolium* (Card.) Iwats., *T. deplanatum* (Sull.) Fleisch. et *T. taxirameum* (Mitt.) Fleisch.; *Sharpiella seligeri* (Brid.) Iwats., *S. striatella* (Brid.) Iwats. et *S. turfacea* (Lindb.) Iwats.

Pour les genres et les espèces, des descriptions et un code explicatif ont été ajoutés. Chaque espèce est pleinement illustrée et sa répartition reportée sur une carte.

On a étudié les chromosomes dans les cellules-mères des spores, pour les espèces suivantes: *Plagiothecium denticulatum* n = 10, 11 et 20; *P. laetum* n = 10 et 11; *P. piliferum* n = 11; *P. undulatum* n = 11; et *Isopterygium elegans* n = 11. L'ouvrage comprend une brève description du comportement des chromosomes, et de nombreuses illustrations de figures méiotiques.

Summary

The genus *Plagiothecium* (Musci) is revised for North America, north of Mexico, after the last revision for this region by Grout in 1932. Over 4,000 herbarium specimens were examined in the study, and specimens of most taxa were seen and collected in the field from many North American localities. Chromosome counts were made on samples from 25 populations from Washington and Idaho, representing five species, two of which had not previously been counted.

The revision recognizes 18 species for North America, north of Mexico. The genera *Isopterygium*, *Taxiphyllum*, and *Sharpiella* (*Dolichotheca*) are segregated from the genus *Plagiothecium*. The following species are recognized: *Plagiothecium denticulatum* (Hedw.) B.S.G., *P. laetum* B.S.G., *P. latebricolum* B.S.G., *P. piliferum* (Hartm.) B.S.G., *P. roeseanum* B.S.G., and *P. undulatum* (Hedw.) B.S.G.; *Isopterygium distichaceum* (Mitt.) Jaeg. et Sauerb., *I. elegans* (Brid.) Lindb., *I. muellerianum* (Schimp.) Jaeg. et Sauerb., *I. pulchellum* (Hedw.) Jaeg. et Sauerb., and *I. tenerum* (Sw.) Mitt.; *Taxiphyllum alternans* (Card.) Iwats., *T. cuspidifolium* (Card.) Iwats., *T. deplanatum* (Sull.) Fleisch., and *T. taxirameum* (Mitt.) Fleisch.; *Sharpiella seligeri* (Brid.) Iwats., *S. striatella* (Brid.) Iwats., and *S. turfacea* (Lindb.) Iwats.

Keys and descriptions are provided for the genera and species. Each species is fully illustrated, and its distribution is plotted on a map.

The chromosomes in the spore mother cells were studied in the following species: *Plagiothecium denticulatum* n = 10, 11, and 20; *P. laetum* n = 10 and 11; *P. piliferum* n = 11; *P. undulatum* n = 11; and *Isopterygium elegans* n = 11. The chromosome behaviour is briefly described, and many meiotic figures are illustrated.

Introduction

Plagiothecium, a genus of mosses in the family Hypnaceae, was described in 1851 by Bruch, Schimper, and Gümbel in *Bryologia Europaea*. The main characters used to distinguish the new genus from the other genera in the family were the flattened or complanate leaves, which are seldom secund. Thirteen European species were recognized by the authors, six of which were described as new, five were transferred from *Hypnum*, and two from *Leskea*. The species described and illustrated are as follows (new species described by B.S.G. indicated by asterisk):

P. denticulatum (*Hypnum*)
**P. laetum*
**P. latebricolum*
**P. muehlenbeckii*
**P. neckeroideum*
P. nitidulum (*Hypnum*)
**P. orthocladium*
P. piliferum (*Leskea*)
P. pulchellum (*Leskea*)
**P. roeseanum*
P. silesiacum (*Hypnum*)
P. sylvaticum (*Hypnum*)
P. undulatum (*Hypnum*)

In 1860 Schimper described another new species, *Plagiothecium muellerianum*. He contrasted it with *P. pulchellum* and stated that both the gametophyte and sporophyte are different.

The genus *Isopterygium*, also in the Hypnaceae, was described in 1869 by Mitten, who recognized eight species for the West Indies and South America. Five of the species were transferred from *Hypnum*, while three were described as new. The distinguishing characters of this genus were the procumbent stems with branches of unequal length, the distichous compressed leaves with narrow cells, and the inclined to horizontal capsules. Of the following species recognized by Mitten, only *I. planissimum* and *I. tenerum* are known north of Mexico (new species described by Mitten indicated by asterisk):

**I. affusum*
I. brachyneuron (*Hypnum*)
I. chrismari (*Hypnum*)
I. curvicollum (*Hypnum*)
I. leucophyllum (*Hypnum*)
**I. planissimum* (= *Taxiphyllum taxirameum*)
**I. tenerifolium*
I. tenerum (*Hypnum*)

In 1874 Lindberg decided that a new genus should be erected for a European species of *Plagiothecium* that he had described six years earlier, namely *P. repens* [= *P. seligeri* (Brid.) Lindb.]. He therefore described the genus *Dolichotheca*, splitting it from *Plagiothecium* because of the noncomplanate leaves and the narrow cylindric capsules. It was later discovered that the name *Dolichotheca* is a later homonym, which was used in 1827 for a genus in the Compositae. Consequently, Iwatsuki (1965) gave the genus the name *Sharpiella*, in honour of A. J. Sharp.

Fleischer, in 1922, described the genus *Taxiphyllum* and included in it ten species for the entire world. The species were transferred from a number of hypnaceous genera in an attempt to bring together dioicous species with leaf cells often dorsally papillose, a long-rostrate operculum, and no propagula. The following species were listed by Fleischer (those known north of Mexico indicated by asterisk):

**T. deplanatum*	*T. splendescens*
**T. geophilum* (= *T. taxirameum*)	*T. splendidum*
T. giraldii	*T. squamatulum*
T. maniae	**T. taxirameum*
T. planifrons	*T. thamnioides*

Still another genus, *Plagiotheciella*, was proposed by Fleischer in 1922 for a single species, *Plagiothecium latebricolum* B.S.G. However, he did not describe the genus. It was not described until 1925, when Brotherus included two more species of *Plagiothecium*, namely *P. piliferum* (Hartm.) B.S.G. and *P. passaicense* Aust. The key characters distinguishing this genus were the long decurrent, more or less unsymmetric leaves with narrow cells, and the erect, symmetric capsules with the inner peristome having a low basal membrane and no cilia.

More species were subsequently added to most of the genera by various authors, and the following numbers of species for the world were listed by Brotherus in 1925:

	Number of species		Number of species
Isopterygium:	169	*Sharpiella* (as *Dolichotheca*):	3
Plagiotheciella:	3	*Taxiphyllum:*	15
Plagiothecium:	70		

After 1925, when all five genera had been described, bryologists publishing in various floras in North America have chosen to treat the *Plagiothecium* complex in a number of different ways. There has been little agreement on whether the taxa should remain in one large genus, *Plagiothecium*, or be split into several subgenera or genera.

The North American (north of Mexico) species of *Plagiothecium* were last revised in 1932 by A. J. Grout in his *Moss Flora of North America*. With representative species in all the segregate genera, he chose to divide *Plagiothecium* into three subgenera comprising 19 species[1], 12 varieties, and three

[1]It is not clear whether Grout intended some of the taxa to be species or subspecies, and because of this ambiguity I am referring to them as species.

forms. Listed below are the subgenera with the species that he attributed to North America:

Euplagiothecium	*Isopterygium*	*Taxiphyllum*
P. denticulatum	*P. elegans*	*P. deplanatum*
P. laetum	*P. micans*	*P. geophilum*
P. latebricolum	*P. muellerianum*	*P. mariannae*
P. piliferum	*P. pulchellum*	
P. roeseanum	*P. seligeri*	
P. ruthei	*P. subfalcatum*	
P. striatellum	*P. turfaceum*	
P. sylvaticum		
P. undulatum		

Since Grout's revision, there has been only one species in the *Plagiothecium* complex, *Taxiphyllum howellianum* Crum and Anders., described as new for North America. In addition, *Plagiothecium platyphyllum* Mönk. and *P. planissimum* (Mitt.) Bartr. were collected and reported as additions to the flora, and *Glossadelphus andersonii* Bartr. was transferred to the genus *Taxiphyllum.*

The main reason for selecting the genus *Plagiothecium* (*sens. lat.*) for taxonomic revision was the difficulty that I and others experienced in identifying specimens. Two of the worst problems were distinguishing species of the *Taxiphyllum deplanatum – T. taxirameum* complex and of the *Plagiothecium denticulatum – P. laetum* complex. It soon becomes apparent when using Grout's (1932) North American treatment of *Plagiothecium* that his keys contain some insignificant and unreliable characters in the light of recent and more thorough observations. The descriptions are sometimes too brief to be of much value, and there are only a few illustrations of a small number of species. Some of the illustrations, which are taken from other publications, are poor representations of the taxa. An additional reason for revising the genus was to re-evaluate the morphological characters used to define the segregate genera. It was evident that after a period of over thirty years since Grout's treatment a more thorough and comprehensive study of the genus was needed.

Acknowledgments

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Field and Herbarium Studies

During the course of this investigation, several hundred specimens of *Plagiothecium* (*sens. lat.*) were collected in various parts of the United States and Canada. All but three (*Plagiothecium latebricolum*, *Taxiphyllum alternans*, and *T. cuspidifolium*) of the 18 species recognized in this study were seen in the field.

It was necessary to examine numerous specimens, including all types that could be located, from a number of institutions in North America, Europe, and Asia. Over 4,000 specimens were obtained on loan from or were seen in the following herbaria: BM, BP, BR, C, CAN, CM, DPU, DUKE, F, FH, FSU, G, H, K, LAF, MAK, MANCH, MICH, MIN, MONTU, NICH, NY, PC, SMS, S-PA, TENN, TNS, TRTC, UAC, UBC, UMBS, UPS, US, W, WTU. In addition, specimens were seen from the herbarium of Dr. Elva Lawton (LAWT) of the University of Washington.

Only specimens personally examined were used to plot the distributions of the species treated in this study. Distributional records of species reported in the literature are often unreliable because of the considerable taxonomic confusion among so many members of the *Plagiothecium* complex.

Chromosome Studies

Chromosome studies on plants from Washington and Idaho represent the first of such investigations known to have been made on material from the *Plagiothecium* complex collected west of the Rocky Mountains. Previous chromosome studies of specimens from the complex have been confined to collections from Canada, eastern United States, Europe, and Asia. A summary of these studies is presented in Table I.

MATERIALS AND METHODS

All the chromosome studies were made on spore mother cells during meiosis. Mosses with young sporophytes were collected with an ample amount of the substratum. The plants were brought back to the laboratory, placed in glass dishes supplied with water, and stored in a cold room until they could be examined.

TABLE I

Chromosome numbers reported for *Plagiothecium*, *Isopterygium*, *Taxiphyllum*, and *Sharpiella*

Genus and Species	Chromosome number n =	Locality	Investigator
Plagiothecium:			
P. denticulatum (Hedw.) B.S.G.	10	Finland	Vaarama, 1950
	10	Asia	Yano, 1957*a*
	10	Asia	Yano, 1957*b*
	11	Europe	Vaarama, 1956
	20	Quebec	Al-Aish and Anderson, 1960*b*
	20	North Carolina	Anderson and Bryan, 1958
	25	Alberta	Anderson and Crum, 1959
P. laetum B.S.G.	11(10+1)	New York	Anderson and Al-Aish, 1964
[as *P. denticulatum* var. *laetum* (B.S.G.) Lindb.]	11	Finland	Vaarama, 1950
P. nemorale (Mitt.) Jaeg.	10	Asia	Yano, 1957*a*
	10	Asia	Yano, 1957*b*
P. piliferum (Hartm.) B.S.G.	11	Finland	Vaarama, 1950
P. roeseanum B.S.G.	10	Asia	Yano, 1957*a*
	10	Asia	Yano, 1957*b*
	20	Quebec	Al-Aish and Anderson, 1960*b*
P. sylvaticum (Brid.) B.S.G.	8	Asia	Yano, 1957*a*
	8	Asia	Yano, 1957*b*

TABLE I (conc.)

Chromosome numbers reported for *Plagiothecium*, *Isopterygium*, *Taxiphyllum*, and *Sharpiella*

Genus and Species	Chromosome number n =	Locality	Investigator
Isopterygium:			
I. tenerum (Sw.) Mitt. [as *I. micans* (Sw.) Kindb.]	12(11+1)	Florida	Al-Aish and Anderson, 1960*c*
	12(11+1) (3 populations)	North Carolina	Al-Aish and Anderson, 1962
I. pulchellum (Hedw.) Jaeg. & Sauerb.	11	Alberta	Anderson and Crum, 1959
	22	Alberta	Anderson and Crum, 1959
I. pohliacarpum (Sull. & Lesq.) Mitt.	12	India	Chatterjee and Bhaduri, 1963
[as *I. textori* (S. Lac.) Mitt.]	12	India	Chatterjee, 1964
Taxiphyllum:			
T. aomoriense (Besch.) Iwats. [as *P. aomoriense* Besch.]	10	Asia	Yano, 1957*a*
	10	Asia	Yano, 1957*b*
T. taxirameum (Mitt.) Fleisch.	8	Asia	Yano, 1957*b*
Sharpiella:			
S. turfacea (Lindb.) Iwats. [as *I. turfaceum* (Lindb.) Lindb.] [as *P. turfaceum* (Lindb.) Lindb.]	11	Finland	Vaarama, 1950
	11	Saskatchewan	Bird, 1962

The cytological techniques were mainly those described by Steere, Anderson, and Bryan (1954). In brief, they consisted of squeezing the spore mother cells out of the capsule into a drop of Carnoy's solution (3:6:1) on a slide and allowing the fixative to evaporate almost completely before adding a drop of stain. A cover slip was then added, and pressure was applied to spread the chromosomes. Heat was omitted from the technique, since Al-Aish and Anderson (1960*a*) reported that lack of heat reduces stickiness, enabling the chromosomes to be separated more easily. Both acetic-orcein and aceto-carmine stains were tried; acetic-orcein gave a much better stain since it produced greater contrast between the chromosomes and the cytoplasm.

The genus *Plagiothecium* (*sens. lat.*) was found to be an excellent one for meiotic chromosome studies. A total of 25 populations were investigated (Table II), and a voucher specimen from each population has been deposited in the herbarium of the University of Washington and in my private herbarium.

Observations and counts were made of as many meiotic stages as possible in several sporophytes from each collection. Meiosis generally occurs in capsules that are bright green with a red-tipped operculum, and often, just before or when the annulus becomes pigmented, a light red. The chromosomes stain

intensely after one or two hours, but on rare occasions it is necessary to leave a slide overnight before they are dark enough to count. Sticky chromosomes, which are found in some moss genera (e.g., *Grimmia*), were not observed in any of the collections; clumping was rarely noted.

TABLE II

Populations of *Plagiothecium* and *Isopterygium* sampled for chromosome number and behaviour

Chromosome number n =	Locality	Date	Collector and number
P. denticulatum (Hedw.) B.S.G.			
10	Clallam Co., Wash.	June 23, 1964	Ireland–8682
10	Clallam Co., Wash.	June 23, 1964	Ireland–8683
10	King Co., Wash.	May 8, 1965	Spellenberg, Sutherland and Ireland–9368
10	Stevens Co., Wash.	June 15, 1963	Ireland–7729
10	Whatcom Co., Wash.	March 27, 1963	Ireland–7394
11	King Co., Wash.	May 8, 1965	Spellenberg, Sutherland and Ireland–9365
11	Snohomish Co., Wash.	July 2, 1963	Ireland–7835
20	King Co., Wash.	May 8, 1965	Spellenberg, Sutherland and Ireland–9366
P. laetum B.S.G.			
10	Shoshone Co., Idaho	Sept. 13, 1964	N. and B. Higinbotham–2005
10	Chelan Co., Wash.	July 13, 1963	Ireland–8107
10	Chelan Co., Wash.	July 13, 1963	Ireland–8108
10	Chelan Co., Wash.	July 13, 1963	Ireland–8110
10	King Co., Wash.	June 16, 1964	Ireland–8831
10	Skamania Co., Wash.	July 12, 1964	Ireland–8832
10	Snohomish Co., Wash.	April 12, 1964	Ireland–8605
11	King Co., Wash.	May 8, 1965	Spellenberg, Sutherland and Ireland–9369
11	King Co., Wash.	Aug. 11, 1965	Lawton and Ireland–9471
P. piliferum (Hartm.) B.S.G.			
11	Snohomish Co., Wash.	April 12, 1964	Ireland–8543
11	Whatcom Co., Wash.	March 26, 1963	Ireland–7393
P. undulatum (Hedw.) B.S.G.			
11	King Co., Wash.	May 8, 1965	Spellenberg, Sutherland and Ireland–9367
11	Snohomish Co., Wash.	March 23, 1963	Ireland–7391
11	Snohomish Co., Wash.	April 12, 1964	Ireland–8544
I. elegans (Brid.) Lindb.			
11	Grays Harbor Co., Wash.	March 20, 1965	Largent–185
11	King Co., Wash.	May 8, 1965	Spellenberg, Sutherland and Ireland–9382
11	Snohomish Co., Wash.	March 23, 1963	Ireland–7390

Chromosome numbers are now known for ten species of the *Plagiothecium* complex in North America, including the two reported for the first time in this study (*Plagiothecium undulatum* and *Isopterygium elegans*). These, with the four species reported from Europe and Asia, make a total of 14 species whose chromosomes have been studied. This small number represents less than 5 per cent of the approximately 300 taxa in the *Plagiothecium* complex; however, chromosome counts have been obtained from only a few collections. Therefore, in the discussion that follows, few inferences on species relationships based on chromosome number can be drawn.

RESULTS AND DISCUSSION

Plagiothecium denticulatum (Hedw.) B.S.G., n= 10, 11, and 20 (Plate I, figs. 1–10).

Five of the eight collections of this polymorphic species that were studied had the number n= 10 (figs. 1–3). There were ten darkly stained bivalents of assorted sizes at metaphase I, with the smallest one in each complement always dividing precociously.

In two collections, the number was n= 11 (figs. 4–7). In both these collections, a small, weakly stained m-bivalent was present that displayed the typical precocious disjunction (figs. 5, 7). These small m(minor)-chromosomes, the importance of which is unknown, are prevalent in many of the Musci. Bryan (1955) has presented an interesting discussion on their nature and occurrence.

The plants of the five n= 10 collections and one of the n= 11 collections (9365) appear morphologically similar and represent typical *P. denticulatum*. The other n= 11 collection (7835), however, is a julaceous form that would be referred by many bryologists to the var. *obtusifolium* (Turn.) Moore.

A single collection (9366) was found to be n= 20 (figs. 8–10); therefore its sporophyte is tetraploid. At metaphase I, all 20 bivalents were stained the same intensity, and the two smallest ones were often observed to divide precociously into half-bivalents (fig. 10). No multivalents nor other aberrant behaviour were observed.

The two precociously dividing bivalents in the n= 20 plants, each similar to the single precociously dividing bivalent in the n= 10 plants, strongly indicate that the former are autotetraploids. Because sporophytic regeneration is accomplished so easily in the mosses, autopolyploidy is believed to be common and of considerable importance, often leading to speciation.

The morphology of the tetraploid plants differed somewhat from that of the diploids in a number of respects. The tetraploids were larger plants and had longer stems and slightly larger leaves that were less crowded than those of the diploids. Also, the tetraploids had only a few rounded cells in the triangular, decurrent leaf region. The diploid plants were typical of *P. denticulatum* by possessing many rounded cells in the oval, decurrent leaf region. Finally, many of the tetraploids were dioicous, differing thereby from the common monoicous condition found in the diploid plants. I do not believe that the characters distinguishing the tetraploids from the diploids are important enough to justify taxonomic recognition. Plants similar to the tetraploids have often been named by various bryologists as *P. denticulatum* var. *majus* (Boul.) Limpr. and *P. platyphyllum* Mönk.

Polyploidy has been known to change the sex expression in some species of mosses. For example, in *Mnium cuspidatum* Hedw. the diploid plant (n = 6) is dioicous, and the tetraploid plant (n = 12) is monoicous. In *P. denticulatum*, however, the diploid plant (n = 10) is monoicous while the tetraploid (n = 20) is dioicous in some cases. This type of change (i.e., from the monoicous condition to the dioicous condition) discovered in the present study is apparently rare or unreported in the mosses.

There is one chromosome count of n = 25 that Anderson and Crum (1957) reported for an Alberta collection of *P. denticulatum*. This represents the highest number thus far reported for any member of the Hypnaceae, and only a few pleurocarpous mosses have been reported with a higher chromosome number. Further chromosome studies of *P. denticulatum* are desirable in light of the high incidence of polyploidy.

Plagiothecium laetum B.S.G., n = 10 and 11 (Plate I, figs. 11–18)

The chromosomes were studied from nine collections of this species from Washington and Idaho. The majority of these, or seven collections, were found to have the chromosome number n = 10 (figs. 11–14), a number which had not previously been reported for this taxon. All ten bivalents stained darkly, and meiosis was regular except for the precocious disjunction of the smallest bivalent (fig. 14). The behaviour of the small bivalent was similar to that in *P. denticulatum*. Two collections of *P. laetum* had the chromosome number n = 11 (figs. 15–18). Meiosis was regular in these plants, and their chromosome complements lacked the small, precociously dividing bivalent.

Taxonomically, most of the collections studied could be referred to *P. curvifolium* Schlieph. *ex* Limpr. (2005, 8107, 8110, 8831, 8832, 9369). Many bryologists consider this a species close to, but distinct from, *P. laetum*. There appears to be no difference in chromosome number, morphology, or behaviour in those collections that could be identified as *P. curvifolium* or *P. laetum*.

Plagiothecium piliferum (Hartm.) B.S.G., n = 11 (Plate I, figs. 19–24)

This is the first account of chromosome number and behaviour for North American plants of this species. The number n = 11, observed in the two Washington collections, agrees with the only other report by Vaarama (1950) for a Finnish collection. At metaphase I, ten darkly stained bivalents and one lightly stained m-bivalent were observed in both specimens (figs. 19–24). As usual, the m-bivalent disjoined precociously into half-bivalents (figs. 20, 24), but this was the only chromosome irregularity observed in the numerous meiotic stages examined. Vaarama (1950) made no mention of an m-bivalent in the spore mother cells of the Finnish plants, and no small chromosomes are evident in his illustration.

Plagiothecium undulatum (Hedw.) B.S.G., n = 11 (Plate I, figs. 25–29)

The three collections of this large, distinctive species had the chromosome number n = 11. This count represents the first report for this species. There were 11 large, darkly stained bivalents seen at metaphase I (figs. 25–27). The chromosomes were the largest observed in the genus *Plagiothecium* (*sens. lat.*),

with some over 3μ in length. No m-bivalents were seen, but one of the smallest bivalents was observed to disjoin before the other members of the complement (fig. 28). No other irregularities were noted.

Morphologically, all three collections represent *P. undulatum* in its typical complanate form.

The basic chromosome number of the genus *Plagiothecium* (*sens. str.*) is presently n= 10. Eventually, the basic number may be found to be n= 5, since a collection with n= 25 has been reported for an Alberta collection of *P. denticulatum*. Additional chromosome studies are needed for all species in the genus, and numbers of n= 15 and high multiples of five will possibly be discovered.

Isopterygium elegans (Brid.) Lindb., n= 11 (Plate I, figs. 30–35)

The chromosome number n= 11, reported here, represents the first record for this widespread, dioicous species. Eleven darkly stained bivalents were observed at metaphase I (figs. 30–35) in all three collections studied. Meiosis appeared regular with no aberrant chromosome behaviour evident. A small bivalent was a conspicuous member of the chromosome complement but was not observed to divide precociously.

The number, n= 11, represents the basic number for the genus *Isopterygium* and supports the morphological findings that the genus is distinct from *Plagiothecium* (*sens. str.*) with a basic number of n= 10.

PLATE I

Meiotic chromosome configurations of *Plagiothecium* and *Isopterygium*.
All figures × 750.

Figs. 1–10. *Plagiothecium denticulatum* (Hedw.) B.S.G. (n= 10, 11, 20) 1–3. (n= 10) 1, 2. Polar views of M-I showing 10 bivalents (9368). 3. Polar view of early A-I showing 20 half-bivalents (9368).

4–7. (n= 11) 4. Polar view of M-I showing 11 bivalents (7835). 5. M-I, polar view showing 10 bivalents and two half-bivalents (7835). 6. Polar view of M-I showing 11 bivalents (9365). 7. M-I, polar view showing 10 bivalents and two half-bivalents (9365).

8–10. (n= 20) 8, 9. Polar views of M-I showing 20 bivalents (9366). 10. Polar view of M-I showing 18 bivalents and four half-bivalents (9366).

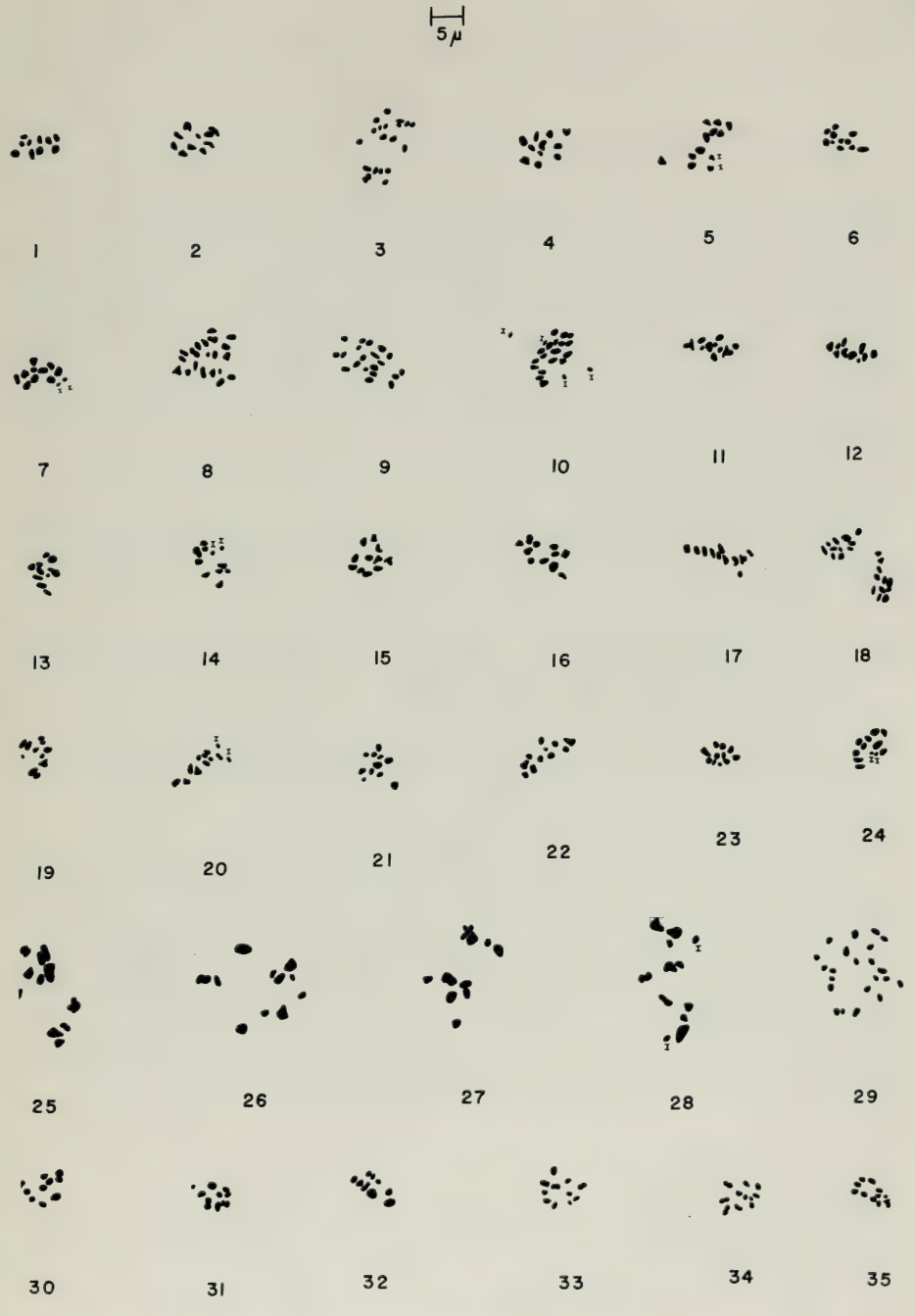
Figs. 11–18. *Plagiothecium laetum* B.S.G. (n= 10, 11) 11–14. (n= 10) 11, 12. Polar views of M-I showing 10 bivalents (8832). 13. Polar view of M-I showing 10 bivalents (8108). 14. M-I, polar view showing 9 bivalents and two half-bivalents (8108).

15–18. (n= 11) 15. Polar view of M-I showing 11 bivalents (9369). 16. Polar view of M-I showing 11 bivalents (9471). 17. Side view of M-I showing 11 bivalents (9471). 18. Polar view of late A-I showing 20 half-bivalents (9471).

Figs. 19–24. *Plagiothecium piliferum* (Hartm.) B.S.G. (n= 11) 19. M-I, polar view showing 11 bivalents (8542). 20. M-I, polar view showing 10 bivalents and two half-bivalents (8542). 21–23. Polar views of M-I showing 11 bivalents (7393). 24. M-I, polar view showing 10 bivalents and two half-bivalents (7393).

Figs. 25–29. *Plagiothecium undulatum* (Hedw.) B.S.G. (n= 11) 25–27. M-I, polar views showing 11 bivalents (7391). 28. Polar view of M-I showing 10 bivalents and two half-bivalents (7391). 29. Early A-I showing 20 half-bivalents (9367).

Figs. 30–35. *Isopterygium elegans* (Brid.) Lindb. (n= 11) 30–32. Polar views of M-I showing 11 bivalents (7390). 33–35. M-I, polar views showing 11 bivalents (185).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Morphological Studies

Stable characters were searched for and used to delimit the genera and species presented in this revision. Because the sporophytes of the members of the *Plagiothecium* complex show little variation, principally gametophytic characters were utilized for the delimitation of taxa. Recently, Iwatsuki (1963), who has studied mainly Asiatic species of the genera *Plagiothecium*, *Taxiphyllum*, *Sharpiella*, and *Isopterygium*, discovered a number of important morphological characters that were not previously utilized, and many of these have helped to establish a stronger morphological basis for certain genera. As a result of using, as far as possible, many stable characters and only the ones that correlate with each other, the genera recognized in this revision are believed to be natural and the species to be sharply delimited.

Cortical Stem Cells

The cortical stem cells are one of the most reliable means of distinguishing genera in the *Plagiothecium* complex. The following two distinct types of cells occur in the group:

1. Outer layer of cells large and thin-walled in cross-section. All *Plagiothecium* and *Sharpiella* taxa, in addition to a single species of *Isopterygium* (*I. muellerianum*), possess this type.
2. Outer layers of cells small and thick-walled in cross-section. All *Taxiphyllum* and *Isopterygium* taxa, except *I. muellerianum*, have this type.

Pseudoparaphyllia

The presence or absence of pseudoparaphyllia, which are present around the branch primordia and mature branches, is of importance at the generic as well as at the specific level. Pseudoparaphyllia are invariably lacking in taxa of the genera *Plagiothecium* and *Sharpiella* and in certain *Isopterygium* species, but they always occur in all species of the genus *Taxiphyllum* and in some species of *Isopterygium*. The four species of *Taxiphyllum* treated in this study have foliose pseudoparaphyllia that consist of two or more rows of cells. In *Isopterygium*, *I. tenerum* (Sw.) Mitt. is the only species in this revision that has pseudoparaphyllia of one row of cells, although a few plants have some with two rows.

Leaves

The leaf size, the shape, the presence or absence of undulations or plications, and the nature of the margins, whether they be plane or recurved, are important at the specific level. The leaf decurrence and the presence or absence of marginal leaf serrations are of value at both the specific and generic level. Taxa of

Sharpiella have decurrent or nondecurrent leaves that are serrulate to serrate to the middle of the leaf or below, but in taxa of *Plagiothecium* the leaves are always decurrent and are entire or have only a few serrulations or serrations at the extreme apex.

The phyllotaxy is considered important and is characteristic for each species recognized in the present revision. Since leaf arrangement is often difficult to describe and equally difficult to picture in one's mind, the habit sketches of the species are intended to solve this problem.

Leaf Cells

The size and shape of the leaf cells, and their character, that is, whether they be papillose or smooth, are important in distinguishing species. In *Plagiothecium* (*sens. str.*) the shape of the alar cells, as well as the shape of the decurrent leaf region, is of utmost importance. In *Taxiphyllum* the number of quadrate alar cells is useful in recognizing some taxa.

Asexual Reproductive Bodies

There are four types of asexual reproductive bodies produced on the leaves or on stems and branches of some species in the *Plagiothecium* complex.

1. Cylindric or fusiform, septate brood-bodies of 2–7 cells. This is the only type known to be produced by *Plagiothecium* (*sens. str.*), and four of the six species treated in this revision are known to produce them. Two species of *Isopterygium* are also known to produce them.

2. Filamentous, sometimes branched, multicellular papillose bodies that often attain a length of 500μ or more. This type is known only for *Isopterygium tenerum* (Sw.) Mitt., which occasionally produces them.

3. Elongate, twisted-vermiform propagula seldom 0.5 mm long with 1–5 acute teeth at apex, rarely with any teeth below. In the present revision, only *Isopterygium distichaceum* (Mitt.) Jaeg. et Sauerb. has propagula of this nature. Similar propagula are reported for a few Asiatic species of the genus *Isopterygium.*

4. Branch-like propagules, often 1 mm long, that resemble the parent plant but bear reduced leaves from the apex to the base of the stem. Some bryologists refer to these as "gemmiform branchlets." *Isopterygium elegans* (Brid.) Lindb. frequently produces them in great abundance, but this is the only species in the *Plagiothecium* complex in the world that was seen with them.

Sexual Condition

The sex of the plant is often helpful in distinguishing species in the *Plagiothecium* complex. The species in this revision are either autoicous or dioicous, and only in *Plagiothecium denticulatum* (Hedw.) B.S.G. are some individuals autoicous, while others are dioicous. All the species of *Sharpiella* are autoicous, while all the *Taxiphyllum* species are dioicous. No sex organs have been found on North American plants of *Isopterygium distichaceum.*

Urn of Capsule

The shape, size, and sometimes colour of the urn are of value in distinguishing species. Striations and wrinkles are characteristic of some species, while in one genus, *Sharpiella*, striations usually occur on the urn of mature, dry, and inoperculate capsules of all North American taxa.

Operculum

The operculum is of some importance in the taxonomy of the group. Conic or rostrate opercula are the two main types occurring in members of the complex. Species of *Sharpiella* have conic opercula, while taxa of *Plagiothecium* and *Isopterygium* have either conic or rostrate opercula, and species of *Taxiphyllum* have long-rostrate opercula.

Peristome

The peristome is of little value in distinguishing taxa in the complex. It is perfect and hypnaceous with minor differences occurring in the number of cilia and exostome markings in the species with erect capsules.

Family Status

The 18 taxa treated in this revision are frequently placed by some bryologists in a single family, the Plagiotheciaceae, or in a single subfamily, the Plagiothecioideae. Others have chosen to put the genera in different families, placing some in the Plagiotheciaceae and others in the Hypnaceae. There seems to be even less agreement in this matter than there is on what genera, if any, should be segregated from *Plagiothecium* (*sens. lat.*). The validity of separating the Plagiotheciaceae from the Hypnaceae was disputed recently by Andrews (1954), with whom I agree. I personally feel that too little is known about the taxa in many of the hypnaceous genera and that more genera need to be revised and monographed before the establishment of families like the Plagiotheciaceae can be justified. At the present time, the family Plagiotheciaceae seems to be merely a weak segregate of the large, complex family Hypnaceae, and I feel that it is prudent to place the genera *Isopterygium*, *Plagiothecium*, *Sharpiella*, and *Taxiphyllum* in this family.

Taxonomic Treatment

After studying specimens representing taxa in the *Plagiothecium* complex, including many type specimens, I have reached the following conclusions as to the genera and species present in North America, north of Mexico.

I. *Plagiothecium*, *Sharpiella*, *Isopterygium*, and *Taxiphyllum* are separate and distinct genera. The four genera are outlined below.

Plagiothecium

1. Leaf base strongly decurrent and clearly defined.
2. Leaves entire or serrulate to serrate at extreme apex.
3. Leaf cells smooth or covered with minute cuticular roughenings in *P. undulatum*.
4. Outer layer of stem cells large and thin-walled.
5. Pseudoparaphyllia lacking.
6. Autoicous or dioicous.
7. Capsules smooth, wrinkled, or striate when dry.
8. Operculum conic or rarely long-rostrate.
9. Cylindric or fusiform brood-bodies of 2–7 cells often present.
10. Distributed in temperate regions.
11. Chromosome number: n = 8, 10, 11, 20, and 25.

North American species: *P. denticulatum* (Hedw.) B.S.G., *P. laetum* B.S.G., *P. latebricolum* B.S.G., *P. piliferum* (Hartm.) B.S.G., *P. roeseanum* B.S.G., and *P. undulatum* (Hedw.) B.S.G.

Sharpiella

1. Leaf base not decurrent or 1–3 cells decurrent or strongly decurrent in *S. striatella*.
2. Leaf margins serrulate to serrate to middle of leaf or below.
3. Leaf cells smooth.
4. Outer layer of stem cells large and thin-walled.
5. Pseudoparaphyllia lacking.
6. Autoicous.
7. Capsules striate or rarely smooth when dry.
8. Operculum conic to short-rostrate.
9. Asexual reproductive bodies lacking.
10. Distributed in temperate regions.
11. Chromosome number: n = 11.

North American species: *S. seligeri* (Brid.) Iwats., *S. striatella* (Brid.) Iwats., and *S. turfacea* (Lindb.) Iwats.

Isopterygium

1. Leaf base not decurrent or *I. tenerum* with 1–2 cells decurrent.
2. Leaf margins entire or serrulate to serrate throughout.
3. Leaf cells smooth or dorsally papillose by projecting cell ends.
4. Outer layers of stem cells small and thick-walled or outer layer large and thin-walled in *I. muellerianum*.
5. Pseudoparaphyllia filamentous or lacking.
6. Autoicous or dioicous.
7. Capsules smooth or sometimes wrinkled when dry.
8. Operculum conic to short-rostrate.
9. Asexual reproductive bodies lacking or present and variable.
   a) Cylindric or fusiform brood-bodies of 2–6 cells.
   b) Elongate, twisted-vermiform propagula with 1–5 acute structures at apex, usually lacking any such structures below.
   c) Branch-like propagules resembling the parent plant but bearing reduced leaves from the apex to the base of the stem.
   d) Filamentous, sometimes branched, multicellular papillose bodies.
10. Distributed chiefly in subtropical or tropical regions.
11. Chromosome number: n = 11, 12, and 22.

North American species: *I. distichaceum* (Mitt.) Jaeg. et Sauerb., *I. elegans* (Brid.) Lindb., *I. muellerianum* (Schimp.) Jaeg. et Sauerb., *I. pulchellum* (Hedw.) Jaeg. et Sauerb., and *I. tenerum* (Sw.) Mitt.

Taxiphyllum

1. Leaf base not decurrent.
2. Leaf margins serrulate to serrate throughout.
3. Leaf cells smooth or dorsally papillose by projecting cell ends.
4. Outer layers of stem cells small and thick-walled.
5. Pseudoparaphyllia foliose.
6. Dioicous.
7. Capsules smooth or sometimes wrinkled when dry.
8. Operculum long-rostrate.
9. Asexual reproductive bodies lacking.
10. Distributed chiefly in subtropical or tropical regions.
11. Chromosome number: n = 8 and 10.

North American species: *T. alternans* (Card.) Iwats., *T. cuspidifolium* (Card.) Iwats., *T. deplanatum* (Sull.) Fleisch., and *T. taxirameum* (Mitt.) Fleisch.

II. Since *Plagiotheciella* cannot be maintained as a separate genus, it is included in the genus *Plagiothecium*. The sporophyte and gametophyte characters used by Brotherus (1925) to define the genus are not sufficiently different from those of the genus *Plagiothecium* to warrant recognition as a segregate genus.

In the keys and descriptions, the measurements of the capsules are of the urn, excluding the operculum, and only the characters of mature, dry, and inoperculate capsules have been utilized. The stem cross-sections are taken near the base of mature stems. The decurrent leaf cells should be observed *in situ*, preferably on leaves in the middle of well-developed stems. The removal of leaves on one side of the stem facilitates the observation of these cells.

KEY TO GENERA

1. Leaves strongly decurrent, entire or serrulate to serrate only at extreme apex; cylindric or fusiform brood-bodies often present on stems and branches or dorsal leaf surfaces ..... *Plagiothecium* p. 20

1. Leaves not decurrent or if decurrent, at least some leaves serrulate to serrate to middle of leaf or below; asexual reproductive bodies present and various or lacking 2

2. Outer layer of stem cells large and thin-walled (evident in cross-section) 3

3. Leaves entire or minutely serrulate; brood-bodies sometimes present; capsules smooth or with a wrinkled neck ..... *Isopterygium* p. 46

3. Leaves serrulate to serrate; asexual reproductive bodies lacking; capsules striate or rarely smooth ..... *Sharpiella* p. 39

2. Outer layers of stem cells small and thick-walled 4

4. Pseudoparaphyllia lacking or present and filamentous, of 1–2 rows of cells; plants often fruiting, autoicous or dioicous; various types of asexual reproductive bodies often present ..... *Isopterygium* p. 46

4. Pseudoparaphyllia present, foliose; plants rarely fruiting, dioicous; asexual reproductive bodies lacking ..... *Taxiphyllum* p. 63

Genus **Plagiothecium** B.S.G., Bryol. Eur. 5: 179. 1851 (fasc. 48 Mon. 1).

Plants dull or glossy, in thin to dense, loose, flat mats, occasionally in erect tufts, light or dark green to yellowish green, sometimes whitish green. Stems and branches green or yellowish green, prostrate and complanate-foliate, sometimes subjulaceous or erect and julaceous, stems simple or irregularly branched, naked or radiculose ventrally; pseudoparaphyllia lacking; outer layer of stem cells large and thin-walled in cross-section. Stem and branch leaves similar, soft, imbricate to distant, erect or spreading, sometimes secund with apices pointing toward substratum, often concave, smooth or undulate, symmetric or asymmetric, strongly decurrent, ovate, ovate-lanceolate, oblong-lanceolate, or oblong-ovate, acute, acuminate, or piliferous; margins plane or recurved, entire or serrulate to serrate at extreme apex; costa short and double, one branch often reaching ⅓–½ length of leaf, rarely one branch poorly developed and costa appearing single, or costa sometimes lacking; leaf cells smooth, or in *P. undulatum* covered by minute, granular, cuticular roughenings,

cell walls usually with a few pits at leaf base, rarely pitted to leaf middle; median cells linear, linear-flexuose, or sometimes linear-rhomboidal; apical cells often shorter than median; basal cells shorter and broader than median; decurrent alar region triangular or often auriculate and oval in outline, consisting of 1–8 vertical rows of spherical, oval, quadrate, or rectangular cells. Brood-bodies often present, cylindrical or fusiform, 2–7 celled, uniseriate, clustered in leaf axils on stems and branches, sometimes borne on dorsal leaf surfaces, hyaline or light green, becoming detached from a stalked, branched base.

Autoicous or dioicous. Perichaetia and perigonia numerous on stems and branches, often clumped at stem base; perigonial bracts short, lanceolate to ovate, acuminate to filiform acuminate. Seta smooth, long, twisted, straight, curved or rarely circinate; yellow, orange, brown, or red. Capsule erect to cernuous, rarely pendulous, straight or arcuate when mature; yellow, orange, brown, or red. Urn oblong or ovoid; when dry, smooth, wrinkled, or striate, tapering to a wrinkled neck; often contracted under mouth. Operculum conic to rostrate, shorter than urn. Annulus of 2–3 rows of deciduous cells, or of 1–2 rows of persistent cells. Peristome perfect, hypnaceous; exostome papillose in upper half, with fine transverse striations between the lamellae in lower half, degenerate in *P. latebricolum* and *P. piliferum* with exostome often papillose to base or nearly so; endostome with 1–3 cilia, as long or nearly as long as segments, or cilia rudimentary or sometimes lacking. Spores globose to ovoid, smooth or minutely papillose, 9–17μ in greatest dimension. Calyptra cucullate white to yellow, fugacious.

Type species, *Hypnum denticulatum* Hedw., Sp. Musc. 237. 1801.

Key to the Species of **Plagiothecium**

1. Plants whitish green, robust; leaves strongly undulate, often 4 mm long or longer ..... *P. undulatum* p. 22

1. Plants smaller with leaves usually less than 4 mm long 2

   2. Leaf apex abruptly contracted to a long, filiform, flexuose acumen, sometimes ⅓ length of leaf ..... *P. piliferum* p. 24

   2. Leaf apex not abruptly contracted to a filiform acumen 3

3. Decurrent portion of leaf often auriculate, oval in outline, composed of many inflated, spherical cells in 2–8 vertical rows; capsules striate or wrinkled ..... *P. denticulatum* p. 26

3. Decurrent portion of leaf never auriculate, tapering and triangular in outline, composed of mostly rectangular cells in 1–5 vertical rows; capsules smooth or sometimes striate or wrinkled 4

   4. Plants small; leaves erect-spreading, mostly 1 mm or less long; dioicous; rare, on rotten wood in wet lowlands ..... *P. latebricolum* p. 30

4. Plants larger; leaves mostly more than 1.5 mm long; autoicous or dioicous; common at low or high altitudes on various substrata 5

5. Median leaf cells 10μ wide or less; plants usually complanate-foliate, often with undulate, flat, asymmetric leaves without recurved apices or sometimes leaves smooth, secund with apices pointing toward substratum; autoicous ..... *P. laetum* p. 35

5. Median leaf cells often over 10μ wide 6

6. Plants usually julaceous with symmetric, concave leaves with apices often recurved; dioicous ..... *P. roeseanum* p. 32

6. Plants complanate-foliate with asymmetric, rarely symmetric flat leaves without recurved apices; autoicous or dioicous ..... *P. denticulatum* p. 26

Plagiothecium undulatum (Hedw.) B.S.G., Bryol. Eur. 5: 195. 1851 (fasc. 48 Mon. 17. 13).

Hypnum undulatum Hedw., Sp. Musc. 242. 1801. Type: "In silvis densis acerosis ad terram, in cavernosis saxosis Europae, in Hercynia, Franconia." (Holotype G! Specimen in Hedwig-Schwaegrichen Herbarium with no information on packet.)

Stereodon undulatus (Hedw.) Mitt., J. Linn. Soc. Bot. 8: 39. 1865.

Neckeropsis undulata (Hedw.) Kindb. *ex* Allen, Mosses Cascade Mts. Wash. 117. 1900. (Later homonym) (*non* (Hedw.) Reichdt. 1870).

Plagiothecium undulatum var. *myurum* Card. et Thér., Univ. Calif. Publ. Bot. 2: 304. 1906. Type: "Unalaska (17 in parte)," collected by W. A. Setchell, June-August, 1899. (Holotype PC!).

Plagiothecium undulatum ssp. *subneckeroideum* Kindb., Ottawa Natural, 23: 138. 1909; Rev. Bryol. 36: 42. 1909. Type: "On earth. Newcastle Island. Departure Bay, Vancouver Island, B.C., July 10th, 1908. Coll. John Macoun."

Plagiothecium undulatum f. *myurum* (Card. et Thér.) Jedl., Publ. Fac. Sci. Univ. Masaryk, ser. L2, no. 308: 14. 1948.

Plagiothecium myurum (Card. et Thér.) Jedl., Publ. Fac. Sci. Univ. Masaryk, ser. L4, no. 318: 4. 1950.

Plants dull or somewhat glossy, light green or whitish green, sometimes yellowish green, stems to 10 cm long or longer, 1–7 mm wide. Stems and branches prostrate and complanate-foliate or sometimes erect and julaceous. Leaves imbricate, not spreading, strongly undulate, especially near apex, somewhat contorted near stem and branch apices, concave, usually symmetric, 2–5 × 1–2 mm, ovate to ovate-lanceolate, rarely oblong-lanceolate, acute to acuminate; margins plane, entire or usually serrulate to serrate at apex; costa short and double, ending a short distance above base, rarely one branch reaching ⅓ length of leaf; leaf cells covered with minute, granular, cuticular roughenings, with pits in walls of basal cells; median cells 96–175 × 7–11μ; decurrent

alar region triangular in outline, consisting of 1–3 vertical rows of rectangular cells, 40–132 × 9–22μ, terminating at the base in a single cell. Asexual reproductive bodies unknown.

Dioicous, often fruiting. Seta 2.5–4.5 cm long, often curved, rarely circinate, dark red to light brown. Capsule inclined to pendulous, arcuate, or sometimes straight, light brown to orange-brown when mature. Urn 1.5–4.0 × 0.4–0.9 mm, wrinkled, contracted below mouth when dry. Operculum rostrate, 0.8–1.2 mm long. Annulus deciduous. Cilia 2–3.

HABITAT. At low altitudes in coniferous woods, often on rotten logs, stumps, and bases of trees; sometimes on boggy soil or soil and humus overlying rock.

DISTRIBUTION. Common in Alaska, Aleutian Islands, British Columbia, Washington, Oregon, California, and Idaho; reported from Europe and Asia (Map fig. 1).

Illustrations: Plates II and III.

Chromosome number: n= 11.

Selected Specimens Examined

EXSICCATI. Allen, Mosses Cascade Mts. Wash. 117 as *Neckeropsis undulata* (DUKE, NY, TENN, UBC, WTU); Grout, N. Amer. Musci Pl. 72 (CAN, TENN, US, WTU); Macoun, Can. Musci 314 as *Hypnum undulatum* (CAN, US).

CANADA. *British Columbia*: Near Vancouver, Indian Arm, Wigwam Creek, *Schofield 20500* (CAN, UBC); Prince Rupert, *Schofield 13894* (CAN, UBC); Queen Charlotte Islands, Graham Island, Massett, *Schofield 14263* (CAN, DUKE, UBC).

U.S.A. *Alaska*: Ketchikan, *Eyerdam 641* (US, WTU); Aleutian Islands, Attu Island, Sarana Bay Area, E. from Chithagof Harbor Road, Engineer Canyon, *Hardy 3* (WTU). *California*: Humboldt Co., Bishop Pine Lodge, 3 mi. S. of Trinidad, *Whitehouse 21754* (DUKE, US). *Idaho*: Kootenai Co., Traille River Basin, *Leiberg*, May 1889 (NY). *Oregon*: Curry Co., Redwood State Park, 8 mi. E. of Brookings, S. bank of Chetco River, *Koch 3296* (CAN, DUKE, NY, TRTC, US, WTU); Lincoln Co., Depoe State Park, *Schofield 21912* (CAN, UBC). *Washington*: Jefferson Co., Olympic National Park, along Hoh River Trail, *Ireland 9008* (CAN); Pierce Co., Mt. Rainier National Park, trail to Denman Falls, along St. Andrews Creek, *Ireland 8332* (CAN); Snohomish Co., Mount Baker National Forest, base of Mt. Pilchuck, near Verlot, *Ireland 8544* (CAN, WTU).

Plagiothecium undulatum is one of the most distinctive species in the genus, and the plants are the largest in North America and probably in the world. Because it is so easily identified, it is not necessary to examine it microscopically. This is probably the reason that the minute, granular, cuticular roughenings (Plate III, figs. 7, 8) on the leaf cells have hitherto been unreported. They are abundant on all leaf cells and were seen on all the leaves of the numerous collections examined. They are noticeable only at magnifications of 400X or more, and are scarcely discernible when the leaves have been mounted in Hoyer's solution.

The var. *myurum* Card. et Thér. was recognized by Grout (1932) and other bryologists because of its subjulaceous or julaceous branches and its subimbricate, concave, smooth or slightly undulate, often obtuse leaves. It is not worthy of taxonomic rank. Typical *P. undulatum* plants from Pacific Co., Washington, with prostrate, complanate-foliate stems and branches, and strongly undulate leaves, were grown in a large covered dish on a window ledge in the laboratory. Under these conditions of relatively high humidity and strong light, the stems produced numerous erect, julaceous branches with nonundulate leaves, similar to those in the type of the var. *myurum*. It therefore is apparent that plants named the variety are nothing more than an environmental form and that any *P. undulatum* plant is capable of producing julaceous branches under the right conditions.

Plagiothecium piliferum (Hartm.) B.S.G., Bryol. Eur. 5: 186. 1851 (fasc. 48 Mon. 8. 3).

Leskea pilifera Sw. *ex* Hartm., Handb. Skand. Fl. (Ed. 1) 419. 1820. Type: "Haga-Park prope Holmiam cl. Swartz." (Holotype? UPS! Specimen seen without locality on packet but with "dedit Swartz.")

Hypnum denticulatum var. *piliferum* (Hartm.) Wahlenb., Fl. Suec. (Ed. 1) 2: 710. 1826.

Hypnum orthocarpon Ångstr., Musc. Scand. 2. 1842. (*nom. nud.*)

Neckera pilifera (Hartm.) Spruce, Musc. Pyren. Exsic. 66. 1847.

Hypnum trichophorum Spruce, Ann. Mag. Nat. Hist. ser. 2, 3: 276. 1849. Type: "ad latera scopulorum graniticorum versus terram spectantia, in umbrosissimis vallis Jéret, P. occ."

Plagiothecium piliferum var. *brevipilum* B.S.G., Bryol. Eur. 5: 186. 1851 (fasc. 48 Mon.8.). Type: "in Norvegiae valle Guldbrandsdalen (Blytt). In America septentrionali (Drummond)."

Hypnum trichophorum var. *brevipilum* (B.S.G.) Kindb., Bih. K. Svensk. Vet.-Ak. Handl. 7(9): 38. 1883. ("*brevipile*").

Plagiothecium trichophorum (Spruce) Vent. et Bott., Atti Soc. Critt. Ital. 3: 170. 1884.

Isopterygium piliferum (Hartm.) Loeske, Stud. Morph. Syst. Laubm. 169. 1910.

Plagiotheciella pilifera (Hartm.) Fleisch. *ex* Broth. *in* Engl. et Prantl, Natür. Pflanzenfam. Ed. 2, 11: 466. 1925.

Plagiothecium piliferum f. *brevipilum* (B.S.G.) Mönk., Laubm. Eur. 860. 1927. ("*brevipila*")

Dolichotheca pilifera (Hartm.) Fleisch. *ex* Podp., Consp. Muscorum Europaeorum 683. 1954.

Plants glossy, light green to yellowish green, stems to 6 cm long, 1.0–1.5 mm wide. Stems and branches prostrate, complanate-foliate to subjulaceous. Leaves imbricate, not undulate, usually concave, symmetric, 0.8–2.0 × 0.4–0.8 mm,

oblong-ovate, abruptly contracted to a long, filiform, flexuose acumen, sometimes ⅓ length of leaf; margins usually narrowly recurved nearly to apex, entire or minutely serrulate at apex; costa short and double, ending a short distance above leaf base, sometimes lacking; leaf cells smooth, with pits in walls of basal cells; median cells 36–96 × 3–5μ; decurrent alar region triangular in outline, consisting of 2–4 vertical rows of rectangular cells, 16–75 × 7–20μ, terminating at the base in a single cell. Asexual reproductive bodies unknown.

Autoicous, often fruiting. Seta 0.8–1.5 cm long, straight, yellow to red. Capsule erect or sometimes slightly inclined, straight, light brown to yellowish or reddish brown when mature. Urn 1–4 × 0.5–1.0 mm, smooth or slightly wrinkled when dry, strongly wrinkled at neck, usually contracted below mouth. Operculum conic, 0.4–0.7 mm long. Annulus deciduous. Cilia usually lacking, or 1–2 rudimentary, fragile cilia present.

HABITAT. At low elevations in coniferous or alder–maple woods, on trees (usually alder, rarely maple), rotten logs, and noncalcareous cliffs and boulders; sometimes on wood in swampy areas.

DISTRIBUTION. Not uncommon in Alaska, British Columbia, Washington, Oregon, Idaho, and Montana; reported from Europe and Asia (Map fig. 1).

Illustrations: Plate IV.

Chromosome number: n = 11.

Selected Specimens Examined

EXSICCATI. Grout, N. Amer. Musci Per. 16 (CAN, NY, TENN, UBC, US, WTU); Grout, N. Amer. Musci Pl. 71 (CAN, NY, TENN, US, WTU); Macoun, Can. Musci 305 as *Hypnum trichophorum* (CAN, NY, US).

CANADA. *British Columbia:* Selkirk Mountains, Roger's Pass, *Macoun*, Aug. 5, 1890 (CAN, NY, US, WTU); Ucluelet Highway, 37 mi. E. of Tofino, near Taylor River flats, *Schofield 13551* (CAN, DUKE, UBC, US, WTU); Queen Charlotte Islands, Maude Island, Skidegate Inlet, *Schofield 15661* (CAN, DUKE, UBC).

U.S.A. *Alaska:* Skagway, *Williams 727* (NY, US); Shumagin Islands, Mist Harbor, *Martel 304* (WTU). *Idaho:* Bonner Co., along Indian Creek, E. side of Priest Lake, *Ireland 8635* (CAN). *Montana:* Flathead Co., Glacier National Park, Lake McDonald, base of Mount Brown, *Hermann 18228* (CAN, NY); Lake Co., Flathead Lake, above Skidoo Bay, upper reaches of Station Creek, *Schofield 11605* (CAN, DUKE, UBC). *Oregon:* Linn Co., House Rock Forest Camp, U.S. Highway 20, 14 mi. E. of Cascadia, *Young 129* (WTU). *Washington:* Mason Co., Olympic National Park, Lake Cushman area along road between Staircase Campground and park entrance, *Lawton 4020* (UBC, WTU); Pierce Co., Mount Rainier National Park, Van Trump Trail, between Christine and Comet Falls, S. side of Mount Rainier, *Ireland 7950* (CAN); Snohomish Co., Mount Baker National Forest, base of Mount Pilchuck, near Verlot, *Ireland 8543* (CAN, WTU); Whatcom Co., 7 mi. E. of Glacier, along road to Mount Baker Ski Lodge, *Ireland 7393* (CAN, WTU).

Although the endostome cilia are frequently lacking in *P. piliferum*, the peristomes of some capsules on the North American plants were found to have one or two rudimentary ones. The cilia are fragile and are frequently broken off, thus appearing as though none were ever present. Nyholm (1965) is evidently one of the few bryologists who has also reported cilia for this distinctive species. It is of interest to note that the absence of cilia is one of the main characters used by Brotherus (1925) to define the genus *Plagiotheciella*, in which this species is sometimes placed.

The outer peristome teeth of *P. piliferum* and of *P. latebricolum* are degenerate, differing somewhat from the other species in the *Plagiothecium* complex. Both species have outer teeth that are papillose from the apex to the base or occasionally with a few transverse striations at the base. Taxa in other moss genera with erect, symmetric capsules often have peristomes with similar markings. All the other members of the complex have teeth with markings that are characteristic of cernuous, unsymmetric capsules, common in the Hypnaceae; that is, the outer peristome teeth are papillose in the upper half and have fine transverse striations between the lamellae in the lower half.

Plagiothecium denticulatum (Hedw.) B.S.G., Bryol. Eur. 5: 190. 1851 (fasc. 48 Mon. 12. 8).

Hypnum denticulatum Hedw., Sp. Musc. 237. 1801. Type: "Hedw. St. Cr. IV. p. 81. t. 31," collected by Starke, possibly in Germany. (Lectotype G! Herb. no. 1828/10).

Hypnum denticulatum var. *obtusifolium* Turn., Musc. Hib. 146. 1804. Type: "Hanc varietatem in summo montis Bulbein jugo ab oculatissimo D. Brown lectam."

Hypnum donnianum Sm., Fl. Brit. 3: 1286. 1804. Type: "E. Scotia misit D. & G. Donn." (Holotype BM!)

Hypnum obtusifolium (Turn.) Brid., Sp. Musc. 2: 93. 1812.

Leskea flaccida Brid., Bryol. Univ. 2: 308. 1827. Type: "In Republica Massachusets Americae Foederatae çirca Noveboracum in rupibus habitat," no collector or date cited.

Hypnum cavifolium Brid., Bryol. Univ. 2: 556. 1827. ("*cavifolius*") Type: "In insula Terra Neuve in terra habitat. La Pylaie detexit."

Hypnum denticulatum var. *donnianum* (Sm.) Hook. et Tayl. *in* Drumm., Musci Amer. (Rocky Mts.) 165. 1828. ("*donianum*")

Plagiothecium denticulatum var. *densum* B.S.G., Bryol. Eur. 5: 191. 1851 (fasc. 48 Mon. 13.). Type: None listed.

Plagiothecium denticulatum var. *laxum* B.S.G., Bryol. Eur. 5: 191. 1851 (fasc. 48 Mon. 13.). (*non* Saut. *ex* Rabenh. 1861) Type: None listed.

Stereodon denticulatus (Hedw.) Mitt., J. Linn. Soc. Bot. Suppl. 1:104. 1859.

Stereodon donnianus (Sm.) Mitt., J. Linn. Soc. Bot. Suppl. 1:104. 1859. ("*donianus*")

Plagiothecium denticulatum var. *donnianum* (Sm.) Lindb., Bot. Notis. 1865: 143. 1865. ("*donnii*")

Plagiothecium donnianum (Sm.) Mitt., J. Linn. Soc. Bot. 12: 520. 1869. ("*donianum*")

Plagiothecium denticulatum var. *crispatulum* Lindb., Act. Soc. Fauna et Fl. Fenn. 10: 278. 1872. Type: "in silvis ad Bai de Castries, 14 Julii 1854. Maximovicz."

Plagiothecium denticulatum var. *obtusifolium* (Turn.) Moore, Proc. Roy. Irish Acad. Sci. 1:424. 1873.

Plagiothecium denticulatum var. *undulatum* Ruthe *ex* Geh., Rev. Bryol. 4: 42. 1877. Type: "Dr. R. Ruthe près de Barwalde, dans la Nouvelle-Marche (1873)."

Plagiothecium denticulatum ssp. *sulcatum* Spruce, J. Bot. 18: 355. 1880. Type: None listed.

Plagiothecium denticulatum var. *majus* (Boul.) Delogne, Flore Crypt. Belgique Pt. 1. 251. 1883. Type: "Frahan, Bouillon (Del.); Louette–St.-Pierre (Gravet)."

Hypnum denticulatum var. *majus* Boul., Musc. France 1:84. 1884.

Hypnum denticulatum var. *densum* (B.S.G.) Lesq. et James, Man. Mosses N. Amer. 367. 1884.

Hypnum denticulatum var. *laxum* (B.S.G.) Lesq. et James, Man. Mosses N. Amer. 367. 1884.

Plagiothecium sylvaticum var. *squarrosum* Kindb. *in* Mac., Bull. Torrey Bot. Club 17(11):279. 1890. Type: "On earth at Hastings, Burrard Inlet, B.C., April 27, 1889," collected by Macoun (Holotype? S-PA! Specimen seen stated only "N. Amer., Brit. Columbia. In water.").

Plagiothecium sandbergii Ren. et Card. *in* Holz., Contr. U.S. Nat. Herb. 3:274. 1895. Type: "Hope, Kootenai County; August (No. 1174)," collected in Idaho in 1892 by J. H. Sandberg, D. T. MacDougal et A. A. Heller. (Isotype NY! US!)

Plagiothecium ruthei Limpr., Laubm. 3:271. 1897. Type: "Ostpreussen: Gauleder Forst bei Friedland und im Baraner Forst bei Lyck (Sanio), Braunsberg (Seydler). Westpreussen: bei Raudnitz nächst Rosenberg (v. Klinggraeff). Pommern: bei Swinemünde am schwarzen See am Wege nach Corswant (R. Ruthe). Mark Brandenburg: um Bärwalde in einem Erlenbruch nahe Müggenburg, an der Latzkower Mühle, Bärfelder grosse Mühle am Schmollnitzsee unter Erlen (R. Ruthe). Rhön: zwischen Sphagnum auf Sumpfboden im Stedtlinger Moor (Geheeb)." (Syntypes, R. Ruthe and Geheeb specimens seen. BP!)

Plagiothecium denticulatum f. *propaguliferum* Ruthe *ex* Limpr., Laubm. 3: 268. 1897. ("*propagulifera*") Type: "R. Ruthe am 22. April 1894 in der Nähe der Bollbrücke bei Swinemünde entdeckt."

Plagiothecium denticulatum var. *propaguliferum* (Limpr.) Warnst., Krypt. Fl. Brandenburg 2: 822. 1905.

Plagiothecium ruthei var. *propaguliferum* (Limpr.) Warnst., Krypt. Fl. Brandenburg 2: 826. 1905.

Plagiothecium laetum var. *densum* (B.S.G.) Warnst., Krypt. Fl. Brandenburg 2: 835. 1906.

Plagiothecium denticulatum var. *ruthei* (Limpr.) Riehm., Sitzungsber. Abhand. Naturw. Ges. Isis (Dresden) 65. 1927.

Plagiothecium obtusifolium (Turn.) Amann, Mém. Soc. Vaudoise Sci. Nat. 3(2): 61. 1928.

Plagiothecium denticulatum var. *bullulae* Grout, N. Amer. Musc. Per. 450. 1942. Type: "Atlanta, Boise National Forest, Elmore Co., Idaho, Sept. 22, 1942. F. A. MacFadden." (Isotype NY! TENN! UBC! US! WTU!)

Plagiothecium denticulatum ssp. *donnianum* (Sm.) Giac., Atti Ist. Bot. Univ. Lab. Critt. Pavia ser. 5, 4: 278. 1947. ("*donianum*")

Plagiothecium denticulatum ssp. *denticulatum* (Hedw.) Bertsch, Moosfl. 130. 1949.

Plagiothecium denticulatum ssp. *ruthei* (Limpr.) Bertsch, Moosfl. 130. 1949.

Plagiothecium densum (B.S.G.) Jedl., Publ. Fac. Sci. Univ. Masaryk, ser. L4, no. 318: 6. 1950.

Plants dull or glossy, dark green to yellowish green, stems to 5 cm long, 1–4 mm wide. Stems and branches prostrate, rarely erect, complanate-foliate or sometimes julaceous. Leaves usually imbricate, rarely secund with some apices pointing toward substratum, usually asymmetric, 1.5–4.0 × 0.5–2.0 mm, oblong-ovate or ovate-lanceolate, acute or acuminate; margins broadly recurved nearly to apex or sometimes plane, serrulate at extreme apex, rarely entire; costa short and double, one branch sometimes reaching leaf middle or costa rarely lacking; leaf cells smooth, with a few pits in walls of basal cells, rarely pitted to leaf middle; median cells linear to linear-rhomboidal, 70–180 × 12–21 μ; decurrent alar region often auriculate and oval in outline, consisting of 3–8 vertical rows of spherical, oval, quadrate, and rectangular cells, 19–80 × 19–29μ, usually terminating at the base in several spherical or oval cells, sometimes alar region triangular in outline, composed of quadrate and rectangular cells, terminating at the base in a single cell. Brood-bodies often present, 72–178 × 9–24μ, consisting of 3–7 cells.

Autoicous, sometimes dioicous, often fruiting. Seta 1.5–3.5 cm long, often curved, light brown to red. Capsule cernuous and arcuate, rarely nearly straight and erect or inclined, light brown to orange-brown when mature. Urn 1.5–3.5 × 0.5–1.0 mm; when dry, strongly contracted below mouth, wrinkled or striate, rarely smooth, strongly wrinkled at neck. Operculum short-rostrate, 0.7–1.0 mm long. Annulus deciduous. Cilia 2–3.

HABITAT. Usually at low altitudes (rare above 3,000 ft.) in woods on rotten logs, stumps, bases of trees, or on humus or soil frequently overlying boulders and cliffs.

DISTRIBUTION. Common, in Labrador south to the mountains of North Carolina and Tennessee, west to Manitoba, Minnesota, and Iowa; in the West from Alaska south to Oregon, also in Alberta, Idaho, Montana, Wyoming, Colorado, Utah, Nevada, and New Mexico; reported from Europe, Asia, Africa, and Australia (Map fig. 2).

Illustrations: Plates V and VI.

Chromosome number: n= 10, 11, 20, and 25.

Selected Specimens Examined

EXSICCATI. Allen, Mosses Cascade Mts. Wash. 116 (CAN, NY, TENN, UBC, US, WTU); Grout, N. Amer. Musci Per. 384 as *P. ruthei* (NY, TENN, US, WTU), 450 as *P. denticulatum* var. *bullulae* (NY, TENN, UBC, US, WTU); Grout, N. Amer. Musci Pl. 55, 55a as *P. ruthei* (NY, TENN, US, WTU), 96 (NY, TENN, US, WTU); 267 (WTU), 288 as *P. denticulatum* var. *obtusifolium* (NY, TENN, US, WTU); Grout, N. Amer. Musci Pl. Suppl. 68 (NY); Sull. et Lesq., Musci Bor. Amer. (Ed. 2) 534 as *Hypnum sylvaticum* (NY).

CANADA. *Alberta:* Waterton Lakes National Park, trail to S. end of Cameron Lake, *Ireland 9564, 9570, 9571* (CAN). *British Columbia:* Alice Lake, near Squamish, *Schofield 20647* (DUKE, UAC, UBC). *Labrador:* Northwest River, *Kallio*, July 10–15, 1963 (CAN). *Manitoba:* 8½ mi. N. of town of Cypress River, *Bird 8496* (CAN, UAC). *Ontario:* Algonquin Park, *Macoun*, June 8, 1900 (NY, WTU). *Quebec:* Parc du Mont Tremblant, LaCorniche, E. of Lac Monroe, Comté de Montcalm, *Hermann 16540* (UBC). *Yukon Territory:* Head of Lake Bennett, *Williams 729* (NY).

U.S.A. *Alaska*: Kenai Peninsula, Moose Range, Sterling Highway, 10 mi. S. of Soldatna, *Svihla 4099* (WTU). *Colorado*: Clear Creek Co., Mount Evans, Summit Lake, *Weber, Vaarama and Khanna B11024* (SMS, UBC). *Connecticut*: New Haven Co., near New Haven, Beaver Meadow, *Allen 45* (NY). *Delaware*: County unknown, near Ruthby, *Commons*, June 10, 1895 (UAC). *District of Columbia*: Rock Creek Park, along Bingham Drive, *Hermann*, Aug. 6, 1957 (NY). *Idaho*: Bonner Co., along Indian Creek, E. side of Priest Lake, *Ireland 8576, 8650, 8655* (CAN). *Illinois*: Cook Co., Glencoe, *Taylor 102* (NY). *Indiana*: Allen Co., vicinity of Lake Everett, ca. 10 mi. NW. of Fort Wayne, *Deam 14533* (NY). *Iowa*: Johnson Co., Savage, without additional information (NY). *Maine*: Penobscot Co., E. slope of Ragged Mt., 10½ mi. WSW. of Millinocket, *Hermann 19209* (UBC, WTU). *Maryland*: Frederick Co., Catoctin Mt., along Fishing Creek, 2½ mi. NW. of Bethel, *Hermann 14272* (NY). *Massachusetts*: Berkshire Co., Mount Everett, *Britton*, Sept. 29, 1897 (NY). *Michigan*: Mackinac Co., Bois Blanc Island, *Ireland 5047* (UBC). *Minnesota*: Cook Co., vicinity of Grand Marais, *Holzinger*, July 16 – Aug. 7, 1902 (NY). *Montana*: Flathead Co., Glacier National Park, Logan Pass Area, trail to saddle between Clements and Oberlin Mts., *Ireland 9551* (CAN). *Nevada*: White Pine Co., Nevada National Forest, Snake Mountains, along Baker Creek, *Lawton 2827* (LAWT, NY, WTU). *New Hampshire*: Grafton Co., Grafton, *Hutchinson*, Sept. 29, 1946 (WTU). *New Jersey*: Union Co., Watchung Reservation, near Scotch Plains, *Lawton 578* (*LAWT*). *New Mexico*: Catron Co., Willow Creek, Gilita Camp, *Goodding 73a* (NY). *New York*: Essex Co., Avalanche Pass, Heart Lake Trail, *Ketchledge 784* (NY). *North Carolina*: Watauga Co., Grandfather Mt., *Small and Heller*, July 11, 1891 (NY, US). *Ohio*: Jackson Co., Liberty Township, *Bartley and Pontius 77* (NY). *Oregon*: Linn Co., House Rock Forest Camp, U.S. Highway 20, 14 mi. E. of Cascadia, *Young 160* (WTU). *Pennsylvania*: Adams Co., Chestnut Hill, 2½ mi. W. of Heidlersburg, *Moul 5979* (NY). *Rhode Island*: Providence Co., Providence, *Olney, s. n.*, no date (NY). *Tennessee*: Carter Co., Cherokee National Park, Roan Mt., *Ireland 1548, 1579* (CAN). *Utah*: Beaver Co., Beaver Creek, *Svihla 556* (WTU). *Vermont*: Windsor Co., Woodstock, Mount Tom, *Britton*, July 5, 1910 (NY). *Virginia*: Rappahannock

Co., Shenandoah National Park, Little Devils Stairs, *Schnooberger and Wynne 3241, 3248* (NY). *Washington*: Pierce Co., Mount Rainier National Park, Van Trump Trail, between Christine and Comet Falls, S. side of Mount Rainier, *Ireland 7979* (CAN). *Wyoming*: Carbon Co., Stamp Mill Lake, *Porter 2083* (WTU).

Plagiothecium denticulatum, a common moss in the temperate regions of Europe and North America, is a variable species for which many subspecific taxa have been described. In Europe, for example, Jedlička (1948, 1950) recognized five varieties and nine forms, while for North America various bryologists have reported eight varieties and one form.

After collecting and studying many specimens of *P. denticulatum* in North America, as well as examining numerous herbarium collections, I have chosen to treat it as a single, polymorphic species. All the subspecific taxa reported for North America are based on a few insignificant and variable gametophytic characters that do not correlate with each other. Since no additional characters were found to distinguish any of them, they have been relegated to synonymy.

The types of *P. ruthei* Limpr. from Europe, *P. sylvaticum* var. *squarrosum* Kindb. *in* Mac. from British Columbia, and *P. sandbergii* Ren. et Card. *in* Holz. from Idaho were examined and are considered synonyms of *P. denticulatum*. The Idaho moss is a julaceous form, similar to what has been called *P. denticulatum* var. *obtusifolium* (Turn.) Moore by Greene (1957) and others. I believe that these julaceous plants are nothing more than environmental forms, and that any *P. denticulatum* plant is capable of producing julaceous shoots in the proper environment. A similar situation is found in *P. undulatum*, where the julaceous var. *myurum* Card. et Thér. was found to be an environmental form by using experimental methods (*see* discussion of *P. undulatum*).

Most bryologists report *P. denticulatum* as monoicous (autoicous), but the present study reveals that this is not always true. Occasionally populations are found where both male and female plants are present, in addition to the autoicous plants. This was found to be the case in the tetraploid plants (n= 20) that I studied. Whether the unisexual plants remain unisexual, and functionally dioicous, or eventually become autoicous by producing organs of the opposite sex is not definitely known.

***Plagiothecium latebricolum** B.S.G., Bryol. Eur. 5: 184. 1851 (fasc. 48 Mon. 6. 1).

Type: "In truncis Alnorum semiputridis prope Hurstpierpoint (Sussex) ubi cl. Mitten primus parcissime legit," collected March, 1848; "prope Warrington (Wilson)." (Syntypes, Mitten specimen seen. K!) ("*latebricola*")

Leskea latebricola (B.S.G.) Wils., Bryol. Brit. 329. 1855.

Hypnum latebricolum (B.S.G.) Hobk., Syn. Brit. Moss. 160. 1873. ("*latebricola*")

Isopterygium latebricolum (B.S.G.) Delogne, Flore Crypt. Belgique Pt. 1. 249. 1883. ("*latebricola*")

Plagiotheciella latebricola (B.S.G.) Fleisch., Musci Fl. Buitenzorg 4: 1378. 1922.

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*The "*um*" ending on the specific epithet, which is used here and throughout the revision, is an error. The correct spelling should be *latebricola*.

Plants glossy, light green to yellowish green stems to 2 cm long, 0.5–1.0 mm wide. Stems and branches prostrate to erect, irregularly branched with numerous short branches. Leaves imbricate, erect-spreading, not undulate, usually concave, frequently symmetric, 0.7–1.5 × 0.2–0.5 mm, ovate-lanceolate, acuminate; margins plane or narrowly recurved nearly to apex, entire or sometimes with a few serrulations at apex; costa short and double, ending a short distance above leaf base, often lacking; leaf cells smooth, with pits in walls of basal cells; median cells 52–150 × 4–10μ; decurrent alar region triangular in outline, consisting of 1–5 vertical rows of rectangular cells, 26–72 × 12–19μ, terminating in a single cell at the base. Brood-bodies usually present, 57–108 × 7–14μ, consisting of 3–6 cells.

Dioicous, rarely fruiting. Seta 0.6–1.0 cm long, straight, light brown to orange-brown. Capsule erect, rarely inclined, straight or rarely somewhat arcuate, light brown to orange-brown when mature. Urn 0.5–1.2 × 0.2–0.6 mm, not contracted below mouth, smooth, slightly wrinkled at neck when dry. Operculum conic-apiculate to short-rostrate, 0.4–0.6 mm long. Annulus persistent. Cilia lacking, or with 1–2 rudimentary cilia.

Habitat. At low altitudes in swamps, bogs, marshes, and inundated woods on rotten logs, stumps, bases of trees, and humus.

Distribution. Rare or seldom collected; in Nova Scotia, Quebec, Ontario, Connecticut, Massachusetts, New York, New Jersey, Michigan, and Wisconsin; reported from Europe (Map fig. 2).

Illustrations: Plate VII.

Chromosome number: Not reported.

Selected Specimens Examined

EXSICCATI. Austin, Musci Appal. 353 (CAN, NY, US); Grout, N. Amer. Musci Pl. 25 (CAN, NY, TENN, US, WTU).

CANADA. *Nova Scotia:* Kentville, *Bailey*, Aug. 17, 1901 (NY). *Ontario:* Algonquin Park, Costello Lake, *Cain 3817* (CAN, TRTC, UAC); Ottawa, W. of Victoria Park, Oct. 5, 1907, collector unknown (CAN). *Quebec:* Near Montreal, *Dupret 272* (NY).

U.S.A. *Connecticut:* New Haven Co., East Haven, *Evans*, Jan. 1, 1892 (NY, US). *Massachusetts*: Essex Co., Amesbury, *Huntington*, Dec. 20, 1900 (DUKE, NY); Middlesex Co., Follen Hill, *Reid GM0004* (CAN, DUKE, UAC). *Michigan*: Muskegon Co., Norton Township Park, *Gebben 2* (MICH). *New Jersey*: Bergen Co., Closter, *Austin*, June, 1894 (DUKE). *New York*: Nassau Co., Long Island, Valley Stream, *Grout*, July 9, 1929 (DUKE). *Wisconsin:* Barron Co., 2 mi. S. of Barron, *Cheney*, Dec. 3, 1925 (DUKE).

Plagiothecium latebricolum, the smallest species in the genus, is rare in North America where it occurs only in the northeastern part of the continent. It is sometimes easy to confuse with depauperate forms of *P. laetum* B.S.G., but *P. latebricolum* differs from this autoicous species by its dioicous condition,

small leaves, and outer peristome teeth that are papillose to the base or nearly so. It may be only an environmental form of *P. laetum* growing at low altitudes in wet habitats, and further studies, especially growth studies, are needed to prove this.

The report of *P. latebricolum* from Thurston Co., Washington, by Lawton and Ireland (1964) is based on a misdetermined specimen of young plants of *P. laetum*. Other specimens named *P. latebricolum* from western North America should be carefully checked.

Plagiothecium roeseanum B.S.G., Bryol. Eur. 5: 193. 1851 (fasc. 48 Mon. 15. 12).

Type: "Ad terram arenosam sub Fagis in monte Inselberg Thuringiae cl. A. Roese." (Holotype K!)

Plagiothecium denticulatum var. *myurum* B.S.G., Bryol. Eur. 5: 191 1851 (fasc. 48. Mon. 13.). Type: None listed.

Hypnum roeseanum Hampe *ex* B.S.G., Bryol. Eur. 5: 193. 1851 (fasc. 48 Mon. 15.). (*nom. nud.*)

Plagiothecium sullivantiae Schimp. *in* B.S.G., Bryol. Eur. 5: 194. 1851 (fasc. 48 Mon. 16.). (*nom. nud.*)

Hypnum sullivantiae (B.S.G.) Schimp. *ex* Sull. et Lesq., Musci Bor.-Amer. 78. 1856. (*nom. nud.*)

Hypnum sullivantiae Schimp *ex* Sull., Mosses U.S. 80. 1856. Type: "On rocks, in dense woods, Central and Southern Ohio," collected by Sullivant in Columbus, Ohio? in 1850. (Holotype K!)

Plagiothecium lucens Sauter *ex* Rabenh., Bryoth. Eur. 765. 1864. (*nom. nud.*)

Plagiothecium sylvaticum var. *cavifolium* Jur. *ex* Rabenh., Bryoth. Eur. 765, 843, 843*b*. 1864. (*nom. nud.*)

Plagiothecium sylvaticum var. *myurum* Mol., Alg. Alp. 98. 1865. (*nom. nud.*)

Plagiothecium sylvaticum var. *roeseanum* (B.S.G.) Lindb., Bot. Notis. 1865: 143. 1865. ("*roesei*")

Plagiothecium sullivantiae (Sull.) Schimp. *ex* Jaeg. et Sauerb., Ber. St. Gall. Naturw. Ges. 1876–77: 450. 1878.

Plagiothecium sylvaticum var. *sullivantiae* (Sull.) Schimp. *ex* Rau et Herv., Cat. N. Amer. Musci 43. 1880.

Plagiothecium aciculari-pungens C. Müll. et Kindb. *in* Mac. et Kindb., Cat. Can. Plants 6: 216. 1892. Type: "On earth, Canaan Forks, Queen's Co., N.B., 1889. (J. Moser.)." (Holotype S-PA!)

Plagiothecium attenuatirameum Kindb. *in* Mac. et Kindb., Cat. Can. Plants 6: 277. 1892. Type: "On rocks in Gilmour's Park, Chelsea, Que., September 6th, 1889. (Macoun)." (Holotype S-PA!)

Plagiothecium boscii ssp. *aciculari-pungens* (C. Müll. et Kindb.) Kindb., Can. Rec. Sci. 6(2): 72. 1894.

Plagiothecium laetum ssp. *attenuatirameum* (Kindb.) Kindb., Can. Rec. Sci. 6(2): 72. 1894.

Plagiothecium fallax Card. et Thér., Proc. Wash. Acad. Sci. 4: 336. 1902. Type: "From Douglas Island (Trelease, 1743 in part)," Alaska, June 6, 1899. (Holotype PC! Isotype NY!)

Plants glossy, rarely dull, pale green to yellowish green, stems to 4 cm long, 1–4 mm wide. Stems and branches erect, sometimes prostrate, usually julaceous, rarely somewhat complanate-foliate, often flagelliform and attenuate at apices. Leaves imbricate, rarely distant, usually erect, sometimes spreading, not undulate, strongly concave, rarely nearly flat, usually symmetric, 1–3 × 0.4–1.4 mm, ovate or oblong-ovate, abruptly acute or slenderly acuminate, apex often recurved; margins plane or often narrowly recurved nearly to apex, entire or rarely serrulate near apex; costa short and double, one branch often reaching leaf middle, sometimes one branch poorly developed and costa appearing single or costa rarely lacking; leaf cells smooth, with pits in walls of basal cells; median cells 60–161 × 7–17μ; decurrent alar region triangular in outline, consisting of 1–5 vertical rows of rectangular cells, 28–70 × 12–22μ, terminating at the base in a single cell. Brood-bodies sometimes present, 36–110 × 9–17μ, consisting of 2–7 cells.

Dioicous, rarely fruiting. Seta 1.0–2.6 cm long, straight or somewhat curved, light brown to red. Capsule erect to inclined, straight or often arcuate, light brown to dark red when mature. Urn 1.0–2.5 × 0.3–0.8 mm, when dry contracted below mouth, smooth or often wrinkled or striate, strongly wrinkled at neck. Operculum rostrate, 0.8–1.0 mm long. Annulus deciduous. Cilia 1–3.

Habitat. At low or high altitudes in shaded situations, commonly on soil or humus overlying boulders and cliffs, sometimes on rotten logs, stumps, and bases of trees.

Distribution. Not uncommon in the East, from Labrador and Newfoundland, south to Georgia and west to Ontario, Minnesota, Iowa, Missouri, and Arkansas; less frequent in the West from Alaska to Washington and Idaho; reported from Europe and Asia (Map fig. 3).

Illustrations: Plate VIII.

Chromosome number: n = 10 and 20.

Selected Specimens Examined

EXSICCATI. Austin, Musci Appal. 359 as *P. denticulatum* (UBC), 363, 364, 365 as *P. sylvaticum* (NY, UBC); Grout, N. Amer. Musci Per. 4 as *P. sylvaticum* (CAN, NY, UBC, WTU), 19 as *P. denticulatum* (NY, WTU), 19a as *P. denticulatum* (WTU), 125 as *P. laetum* (NY, WTU), 269 (NY, TENN, UBC, US, WTU), 348 as *P. denticulatum* (UBC, WTU); Grout, N. Amer. Musci Pl. 125 as *P. sullivantiae* (CAN, NY, WTU), 126, 418 as *P. sullivantiae* (NY, US, WTU), 126a, 434 as *P. sullivantiae* (NY, TENN, US, WTU), 468 as *P. denticulatum* f. *propagulifera* (NY); Grout, N. Amer. Musci Pl. Suppl. 10 (NY); Macoun, Can. Musci 312 as *Hypnum sullivantiae* (NY, WTU), 313 as *H. sylvaticum* (NY, TRTC); Sull. et Lesq., Musci Bor. Amer. (Ed. 1) 355, (Ed. 2) 535 as *Hypnum sullivantiae* (NY).

CANADA. *British Columbia*: Near Vancouver, Indian Arm, Wigwam Creek, *Schofield 20532* (UBC). *New Brunswick*: Fredericton, Odell's Wood, *Habeeb 24* (NY). *Newfoundland*: New Harbour, *Waghorne* in 1893 (NY). *Nova Scotia*: Cape Breton Island, mountains W. of Dingwall, *Nichols 1020* (NY). *Ontario*: Grey Co., gorge below Eugenia Falls, *Crum 11566* (CAN, UAC). *Quebec*: West of Hull, *Macoun*, Oct. 5, 1908 (TENN, WTU). *Labrador*: Cape Caribou, Grand Lake, *Kallio*, July 18, 1963 (CAN).

U.S.A. *Alaska*: Kodiak, *Trelease 2191, 2192* (NY); Aleutian Islands, Attu Island, *Howard 256, 299* (US). *Arkansas*: Van Buren Co., W. of Shirley, Middle Fork River, *Redfearn 16569* (SMS). *Connecticut*: New Haven Co., Westville, near New Haven, *Allen*, Oct. 4, 1879 (NY). *District of Columbia*: National Arboretum, *Hermann 15096* (NY). *Georgia*: Rabun Co., Tallulah Falls, *Small 9505* (NY). *Idaho*: Shoshone Co., Mark's Butte, *Sharp*, July 23, 1961 (CAN). *Illinois*: Cook Co., Chicago, *Röll*, Oct. 20, 1888 (NY). *Indiana*: Porter Co., Tremont, *Habeeb 1445* (NY). *Iowa*: Marion Co., Red Rock, *Conard*, Aug. 26, 1936 (NY, WTU). *Kentucky*: Caldwell Co., 7 mi. N. of Princeton, *Harvill 1499* (MICH). *Maine*: Oxford Co., Norway, *Bacon 115* (NY). *Maryland*: Montgomery Co., Great Falls, *Ireland 1767, 1780* (CAN, US). *Massachusetts*: Essex Co., Amesbury, *Huntington* in Grout, *N. Amer. Musc. Pl. 126a* as *P. sullivantiae* (NY, TENN, US, WTU). *Michigan*: Keweenaw Co., Mount Bohemia, W. of Lac La Belle, *Ireland 5368* (CAN, US). *Minnesota*: Chippewa Co., near Montevideo, Cedar Lake, *Holzinger*, June 15–21, 1901 (NY). *Missouri*: Douglas Co., Sweden Hollow, Bryant Creek, *Redfearn and Ireland 9070* (CAN, SMS). *New Hampshire*: Carroll Co., Jackson, *Allen*, Aug. 1, 1878 (NY). *New Jersey*: Bergen Co., Closter, *Austin 353* (NY). *New York*: Hamilton Co., 4½ mi. SW. of Long Lake Village, *Hermann 14590* (UAC, WTU). *North Carolina*: Yancey Co., Middle Creek, *Schofield 9559* (UBC). *Ohio*: Pickaway Co., Jackson Township, *Bartley and Pontius 230* (NY). *Pennsylvania*: McKean Co., Bennett Brook, *Burnett*, Aug. 8, 1897 (NY). *Tennessee*: Sevier Co., Great Smoky Mountains National Park, below Newfound Gap, Walder Camp Prong, *Schofield 10545* (UBC). *Vermont*: Windham Co., Haystack Mt., *Wynne 1985* (NY). *Virginia*: Albemarle Co., Shenandoah National Park, Jones Run Falls Trail, *Ireland 2215* (CAN, US). *Washington*: Pierce Co., Mount Rainier National Park, trail to Denman Falls, along St. Andrews Creek, *Ireland 8338* (CAN). *West Virginia*: Webster Co., Straight Creek Mt., along Ganley River, *Roberts*, June 8, 1934 (NY). *Wisconsin*: Iowa Co., 4 mi. W. of Ridgeway, *Evans 49-24* (WTU).

Most of the North American collections of *P. roeseanum* are misidentified as *P. sylvaticum* (Brid.) B.S.G., a European species that does not occur on this continent. Both species are dioicous, but *P. roeseanum* has narrower median leaf cells (7–17μ wide) in contrast to the broad median cells (12–22μ wide) of *P. sylvaticum*. Also, the plants of the former are julaceous with concave leaves, while those of the latter are complanate-foliate with flat leaves.

The habit of the western plants of *P. roeseanum* is somewhat different from that of plants from east of the Rocky Mountains. They grow in loose, prostrate mats and rarely form the dense, erect tufts that are so prevalent in the East. Further study may show the two to be separate taxonomic entities.

Plagiothecium attenuatirameum Kindb. *in* Mac. et Kindb., considered a form of *P. latebricolum* B.S.G. by Grout (1932), seems better placed in synonymy with *P. roeseanum* because of its julaceous, often flagelliform stems and branches and its large, concave leaves.

Plagiothecium fallax Card. et Thér., described from plants collected in Alaska, appears to be an environmental form of *P. roeseanum* which Grout (l.c.) considered to be a synonym of *P. sylvaticum* var. *succulentum* (Wils.) Husn. Even though some of the plants are nearly complanate-foliate with flat leaves, this seems to be of little importance and does not warrant taxonomic recognition.

Plagiothecium laetum B.S.G., Bryol. Eur. 5: 185. 1851 (fasc. 48 Mon. 7. 2).

Type: "In Rhaetiae Alpe Albula, ubi in regione sylvatica versus Ponte in ligno putrido, et supra hanc regionem prope Weissenstein in rupium fissuris Dicrano gracilescenti intermixtum W. P. Schimper aestate 1845 detexit." (Holotype K!)

Plagiothecium denticulatum var. *tenellum* B.S.G., Bryol. Eur. 5: 191. 1851 (fasc. 48 Mon. 13.). Type: None listed.

Leskea laeta (B.S.G.) Berggr., Lunds Univ. Årsskr. 2 Afd. 3(7): 8. 1865.

Leskea hamosa Ångstr., Bot. Notis. 1866: 102. 1866. Type: "Tagen på Laxfjället i Umeå Lappmark."

Plagiothecium denticulatum var. *laetum* (B.S.G.) Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 9: 31. 1868.

Plagiothecium denticulatum var. *eciliatum* Pfeff., Jahrb. Naturf. Ges. Graubünd. 53. 1868. Type: "Ausser im Adula, wo ich, wie dann auch Freund Holler, um Zervreila dieses Plagiothec. reichlich sammelte, fand ich eine geringere Menge, 1866, am 'Parpaner Rothhorn'."

Plagiothecium denticulatum var. *pusillum* Aust., Musci Appal. 361. 1870. (*nom. nud.*)

Plagiothecium grâvetii Piré, Bull. Soc. Roy. Bot. Belg. 10: 101. 1871. Type: "Rochers humides. Louette St. Pierre (Grav.). Septembre," collected by F. Gravet in 1871, bois humides, prov. de Namur, Belgium, in Les Mousses de l'Ardenne 242. (Isotype? BR!)

Plagiothecium denticulatum var. *hercynicum* Jur. *ex* Grav., Bull. Soc. Roy. Bot. Belg. 13: 430. 1874. Type: "sur les rochers ombragés et au pied des arbres dans les bois humides: Louette-Saint-Pierre!"

Plagiothecium denticulatum var. *pusillum* Rau et Herv., Cat. N. Amer. Musci 43. 1880. (*nom. nud.*)

Plagiothecium denticulatum ssp. *aptychus* Spruce, J. Bot. 18: 355. 1880. Type: "Coneysthorpe Banks, Slater et Stabler. July," collected in 1880. (Holotype MANCH!)

Hypnum denticulatum var. *laetum* (B.S.G.) Lesq. et James, Man. Mosses N. Amer. 367. 1884.

Plagiothecium denticulatum var. *recurvum* Warnst., Verh. Bot. Ver. Brandenburg 27: 73. 1885. Type: "Nr.: Auf nactem Boden in Kiefernschonugen vor Altruppin!!".

Plagiothecium denticulatum var. *microcarpum* Ren. et Card., Rev. Bryol. 15: 71. 1888. ("*microcarpon*") Type: "Idaho, in ligno putrido, misit Ch. R. Barnes," collected in 1888 by J. B. Leiberg, no. 39, Kootenai Co., North Fork Basin. (Isotype NY!)

Plagiothecium decursivifolium Kindb. *in* Mac. et Kindb., Cat. Can. Plants 6: 277. 1892. Type: "On cedar (*Thuja occidentalis*) stumps in a swamp, 5 miles west of Belleville, Ont. (Macoun)." (Holotype ? S-PA!)

Plagiothecium denticulatum var. *gravetii* (Piré) Husn., Musc. Gall. 351. 1894.

Plagiothecium denticulatum var. *aptychus* (Spruce)Lees *ex* Dixon et Jameson, Students Hand. Brit. Mosses (Ed. 1) 436. 1896.

Plagiothecium curvifolium Schlieph. *ex* Limpr., Laubm. 3: 269. 1897. Type: "Schliephacke sammelte die Exemplare, die er 1880 vertheilte, im Thüringerwalde bei der Schmücke in feuchten Nadelwäldern am 29. Juli 1880." (Holotype BP!)

Plagiothecium denticulatum var. *curvifolium* (Limpr.) Meyl., Bull. Soc. Vaudoise Sci. Nat. ser. 5, 41: 151. 1905.

Plagiothecium laetum var. *tenellum* (B.S.G.) Warnst., Krypt. Fl. Brandenburg 2: 835. 1906.

Plagiothecium laetum var. *neomexicanum* Card., Rev. Bryol. 37: 57. 1910. Type: "New Mexico: Sacramento Mts., Otero County (E. O. Wooton, 1899)," collected Aug. 8, no. 3759. (Holotype PC! Isotype DUKE!)

Plagiothecium denticulatum ssp. *laetum* (B.S.G.) Meylan, Rev. Bryol. 38: 88. 1911.

Plagiothecium tenellum (B.S.G.) Jedl., Publ. Fac. Sci. Univ. Masaryk, ser. L4, no. 318: 6. 1950.

Plants glossy, rarely dull, light green to yellowish green, stems to 2 cm long, 1–3 (rarely 4) mm wide. Stems and branches prostrate, complanate-foliate, rarely somewhat julaceous. Leaves imbricate, rarely distant, erect or spreading, often slightly undulate, sometimes secund with apices pointing toward substratum, usually asymmetric, 0.7–2.6 × 0.3–1.2 mm, oblong-ovate or ovate-lanceolate, slenderly acuminate; margins plane or often narrowly recurved nearly to apex, usually entire or with a few serrulations at apex; costa short and double, ending a short distance above leaf base, rarely with one branch reaching leaf middle, or costa sometimes lacking; leaf cells smooth, with pits in walls of basal cells; median cells 96–168 × 4–10μ; decurrent alar region triangular in outline, consisting of 1–5 vertical rows of rectangular cells, 40–100 × 9–29μ, terminating at the base in a single cell. Brood-bodies usually present, 40–86 × 8–14μ, consisting of 3–6 cells.

Autoicous, often fruiting. Seta 1.0–1.6 cm long, straight or curved, orange-brown to red. Capsule erect to cernuous, straight to arcuate, light brown to orange-brown when mature. Urn 0.5–2.0 × 0.4–0.7 mm, when dry smooth, or rarely wrinkled when arcuate. Operculum conic to short-rostrate, 0.3–0.8 mm long. Annulus deciduous. Cilia 1–3, sometimes lacking.

HABITAT. At high elevations (above 2,000 ft.) or occasionally at low elevations, usually in coniferous woods on rotten logs, stumps, bases of trees, humus or soil, frequently overlying boulders and cliffs.

DISTRIBUTION. Common, in Labrador and Newfoundland, south to the mountains of North Carolina and Tennessee, west to Manitoba, Minnesota, and Iowa; in the West from Alaska south to northern California; also in Alberta, Idaho, Montana, Colorado, and New Mexico; reported from Europe and Asia (Map fig. 3).

Illustrations: Plates IX and X.

Chromosome number: n = 10 and 11.

Selected Specimens Examined

EXSICCATI. Austin, Musci Appal. 362 as *P. denticulatum* var. *laetum* (NY); Farlow, Reliquiae Farlowianae 596 (NY); Grout, N. Amer. Musci Per. 19 as *P. denticulatum* (UBC); Grout, N. Amer. Musci Pl. 93 as *P. denticulatum* (WTU), 267 as *P. denticulatum* (NY); Macoun, Can. Musci 313 as *Hypnum sylvaticum* (WTU).

CANADA. *Alberta*: Waterton Lakes National Park, trail to Carthew Lakes, *Ireland 9559, 9563* (CAN). *British Columbia*: Lakelse Lake, ca. 20 mi. E. of Kitimat, *Schofield and Boas 20918* (CAN, UBC). *Labrador*: Grand Lake, Northwest River, *Wickes*, Aug. 4, 1938 (DUKE, NY, TRTC). *Manitoba*: Between Fort Churchill and Cape Merry, *Crum and Schofield 6928, 6974* (CAN). *Newfoundland*: Green Harbour, *Waghorne*, Oct. 23, 1891 (NY). *New Brunswick*: Fredericton, *Habeeb 545* (DUKE). *Nova Scotia*: Cape Breton Island, near Indian Brook, *Nichols 167* (NY). *Ontario*: Bear Island, Lake Timagami, *Cain 1400* (DUKE, NY, TRTC, WTU). *Quebec*: Gaspé Nord, Gaspesian Park, near Mont Albert, Rivière Ste. Anne Gorge, *Crum and Williams 10563* (CAN). *Yukon Territory*: Bonanza Creek, *Macoun*, July 29, 1902 (NY).

U.S.A. *Alaska*: Pile Bay, Newhalen, Lake Iliamna, *Thomas 51-37* (LAWT). *California*: Santa Cruz Co., ca. 2 mi. up Fall Creek, W. of Felton, *Schofield and Thomas 12934* (UBC). *Colorado*: Gunnison Co., Gothic National Area, 4 mi. N. of Gothic, Bald Mt., along Quigley Creek, *Weber 9239* (DUKE, TRTC, WTU). *Connecticut*: New Haven Co., Beacon Falls, *Nichols 36* (NY). *Idaho*: Shoshone Co., St. Joe National Forest, Buzzard's Roost Road, Jug Camp area, *Higinbotham and Higinbotham 2005* (WTU). *Iowa*: Dubuque Co., Pine Hollow, *Conard*, May 9, 1931 (DUKE). *Maine*: Oxford Co., Canton, *Parlin 12357* (NY). *Massachusetts*: Essex Co., Amesbury, *Huntington*, Dec. 2, 1900 (NY). *Michigan*: Marquette Co., Sugar Loaf Mt., ca. 5 mi. NW. of Marquette, *Ireland 4585* (CAN). *Minnesota*: Cook Co., near Grand Portage, Hat Point, *Holzinger*, Aug. 15, 1902 (NY). *Montana*: Flathead Co., Glacier National Park, Lake McDonald, *Ireland 9554, 9557* (CAN). *New Hampshire*: Coos Co., Mt. Washington, Lake of Clouds, *Allen*, Aug. 15, 1878 (NY). *New Jersey*: Bergen Co., Closter, *Austin* in 1865 (NY). *New Mexico*: Otero Co., Sacramento Mountains, *Wooton 3759* (DUKE, PC). *New York*: Essex Co., near Lake Placid, Wilmington Notch, *Britton*, Sept. 16, 1898 (NY). *North Carolina*: Yancey Co., below summit of Mt. Mitchell, *Hermann 19397* (US, WTU).

Oregon: Douglas Co., near Canyonville, Canyon Creek, *Schofield 22988* (CAN, DUKE, UBC). *Pennsylvania*: McKean Co., ½ mi. NW. of Guffey, Valley of Pine Run, *Moul 5934* (NY). *Tennessee*: Sevier Co., Great Smoky Mountains National Park, Newfound Gap, *Schofield 8852* (DUKE, UBC). *Vermont*: Windham Co., Haystack Mt., *Wynne 1995a* (NY). *Virginia*: Page Co., Shenandoah National Park, Stony Man Mt., *Ireland 3672* (CAN, US). *Washington*: Chelan Co., trail above Stevens Pass Inn, *Ireland 8108* (CAN, WTU). *West Virginia*: Pendleton Co., Monongahela National Forest, 4 mi. W. of Judy Gap, Spruce Mt., *Hermann 20349* (CAN).

There has been much confusion between *P. laetum* and *P. denticulatum* (Hedw.) B.S.G., the two most common species of *Plagiothecium* in North America. They sometimes grow in close proximity but always remain distinct. *Plagiothecium laetum* is distinguished by the often undulate, small leaves (0.7–2.6 × 0.3–1.2 mm), narrow median leaf cells (4–10μ wide), decurrent leaf region that is triangular in outline and composed of rectangular cells, and the smooth, rarely wrinkled or striate short capsule (urn 0.5–2.0 mm long). *Plagiothecium denticulatum* is characterized by the nonundulate, large leaves (1.5–4.0 × 0.5–2.0 mm), the broad median leaf cells (12–21μ wide), the decurrent leaf region that is usually oval in outline and composed of at least some rounded cells, and the wrinkled or striate long capsule (urn 1.5–3.5 mm long). The two are usually very easy to distinguish when found with capsules.

Plagiothecium laetum is a variable species and one that has been poorly understood. The species has two forms, which are often recognized as separate taxa because they frequently appear to be distinct. The most common form has flattened, often undulate leaves and bears capsules that are smooth, straight, and usually erect. Plants of this description have been named *P. decursivifolium* Kindb. *in* Mac. et Kindb., *P. gravetii* Piré, and *P. laetum* var. *neomexicanum* Card. The second variant, abundant in British Columbia and Washington but becoming less frequent in eastern North America, has secund leaves whose apices point toward the substratum and capsules that are smooth or rarely wrinkled or striate, often arcuate, and usually cernuous. Plants with this combination of characters have been named *P. curvifolium* Schlieph. *ex* Limpr., *P. denticulatum* ssp. *aptychus* Spruce, and *P. denticulatum* var. *microcarpum* Ren. et Card. If the characters distinguishing the two forms always correlated, these forms would undoubtedly deserve taxonomic recognition. However, when a large number of specimens are examined throughout the range of *P. laetum*, it soon becomes apparent that the gametophytic and sporophytic characters do not correlate. For example, inclined to cernuous capsules are often found on plants with flat, undulate leaves. Conversely, erect capsules are found on plants with smooth, secund leaves. Because of the lack of correlating characters, I have treated both forms as part of one variable taxon. The cytological evidence obtained from Washington and Idaho plants supports this.

It is noteworthy that even though *P. laetum* often has erect, symmetric capsules, its outer peristome teeth always appear to be well developed with transverse striations extending to the middle of the teeth. This is somewhat unusual for mosses with erect capsules since their peristomes are usually degenerate (*see* discussion under *P. piliferum*), and it may be additional proof that *P. curvifolium* and *P. laetum* are all part of one variable taxon, with capsules that vary from erect to horizontal.

Genus SHARPIELLA Iwats., J. Hattori Bot. Lab. 28: 202. 1965.

Genus *Dolichotheca* Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 13: 417. 1874. (Later homonym) (*non Dolichotheca* Cassini, Dict. Sci. Nat. 51: 476. 1827. = *Coreopsis* in Compositae)

Isopterygium Mitt. subgenus *Dolichotheca* (Lindb.) Lindb., Musci Scand. 39. 1879.

Plants glossy, in thin to dense, loose, somewhat flat mats, light green to yellowish green or dark green. Stems and branches green or yellowish green, sometimes tinged orange or red in spots; prostrate, simple or irregularly branched, branches sometimes ascending or erect and crowded; pseudoparaphyllia lacking; outer layer of stem cells large and thin-walled in cross-section. Stem and branch leaves similar, stiff, imbricate to somewhat distant, spreading or often squarrose to squarrose-recurved, sometimes tips secund at stem and branch apices, concave, smooth or weakly plicate, symmetric, not decurrent or distinctly decurrent, ovate to ovate-lanceolate, acuminate, sometimes abruptly so, the apex often filiform; margins plane, serrulate to strongly serrate above leaf middle, serrate to entire below; costa short and double, one branch often extending ⅓ length of leaf, or sometimes costa ending a short distance above leaf base, rarely lacking; leaf cells smooth, the walls of cells at leaf base usually pitted, sometimes pitted to leaf middle or above, or pits sometimes lacking; median cells linear or linear-flexuose; apical cells shorter than median; basal cells shorter or longer and broader than median cells; alar cells quadrate to short-rectangular, sometimes decurrent and abruptly inflated, rounded to oval, in 2–4 vertical rows of 4–6 cells. Asexual reproductive bodies unknown.

Autoicous, often fruiting. Perichaetia and perigonia numerous, often clumped at stem base. Perigonial bracts short, lanceolate to ovate, acuminate. Perichaetial bracts long, lanceolate to ovate, acuminate or abruptly narrowed to a filiform apex. Seta smooth, long, often twisted, straight or slightly curved, light brown to red. Capsule cernuous, rarely nearly erect, arcuate when mature, light brown to reddish brown. Urn oblong or cylindric; when dry and inoperculate distinctly striate, rarely indistinctly striate or smooth, tapering to a wrinkled neck, often contracted under mouth. Operculum conic to conic-apiculate. Annulus deciduous, of 2–3 rows of large cells. Peristome perfect, hypnaceous, endostome with 1–3 cilia, unequal, approximately the length of segments. Spores globose to ovoid, smooth to minutely papillose, 9–14μ in greatest dimension. Calyptra cucullate, white to yellow, fugacious.

Type species, *Plagiothecium repens* Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 9: 36. 1868.

Key to the Species of **Sharpiella**

1. Leaves with 2–4 rows of distinctly decurrent cells that are abruptly inflated, hyaline or orange to red ..... *S. striatella* p. 40

1. Leaves not decurrent or 1–3 cells in marginal row indistinctly decurrent 2

2. Leaves sometimes plicate, appearing distichous and complanate due to twisting of leaves to form two rows on opposite sides of stems and branches; capsules never over 2 mm long; predominately eastern plants, rare in or west of the Rocky Mountains.... *S. turfacea* p. 43

2. Leaves smooth, not appearing distichous or complanate, but several rows of leaves evident with leaves standing out in all directions at right angles from stems and branches; capsules often over 2 mm long; plants of northwestern United States and southwestern Canada ..... *S. seligeri* p 45

Sharpiella striatella (Brid.) Iwats., J. Hattori Bot. Lab. 28: 203. 1965.

Leskea striatella Brid., Bryol. Univ. 2:762. 1827. Type: "In insula Terra Neuve inter Jungermannias caespitose habitat. Clar. La Pylaie communicavit."

Hypnum chrysophylloides Gümb. *ex* C. Müll., Syn. Musc. Frond. 2: 436. 1851. Type: "In Sudetis ad Kesselkoppe legit Sendtner 24. Aug. 1839."

Plagiothecium muehlenbeckii B.S.G., Bryol. Eur. 5: 189. 1851 (fasc. 48 Mon. 11.6). Type: "Primus omnium Swartzius in Suecia legisse videtur, dein cl. Blytt e Norvegiae alpibus retulit, tandem beatus Mühlenbeck anno 1843 pulcherrimis caespitibus prope pagum Hinterrhein Rhaetiae collegit et nos ipsi copiose legimus in summa Rhaetiae Albula, in graminosis ad terram retro hospitium m. Grimsel, in alpe Dovrefjeld Norvegiae; prope Espingo Pyrenaeorum altiorum (cl. Sarrat-Geniste)." (Syntypes, Mühlenbeck specimen seen, collected in July 1843. K!)

Plagiothecium muehlenbeckii var. *chrysophylloides* (C. Müll.) B.S.G., Bryol. Eur. 5: 189. 1851 (fasc. 48 Mon. 11.).

Hypnum striatellum (Brid.) C. Müll., Syn. Musc. Frond. 2: 282. 1851.

Hypnum muehlenbeckii (B.S.G.) Hartm., Hand. Skand. Fl. Ed. 6: 346. 1854.

Plagiothecium striatellum (Brid.) Lindb., Bot. Notis. 1865: 144. 1865.

Plagiothecium striatellum var. *chrysophylloides* (C. Müll.) Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 9: 33. 1868.

Plagiothecium pseudo-silesiacum Schimp. *ex* Lesq. et James, Proc. Amer. Acad. Arts Sci. 14: 140. 1879. Type: "Near St. Louis," Drummond, Musci Amer. (Southern States) 111 as *Hypnum silesiacum.* (Isotype NY!)

Hypnum fitzgeraldii Ren. *ex* Lesq. et James, Man. Mosses N. Amer. 370. 1884. ("*i*") Type: "Decayed trunks, Florida (Fitzgerald)." (Holotype FH! Isotype NY!)

Hypnum pseudo-silesiacum (Lesq. et James) Lesq. et James, Man. Mosses N. Amer. 370. 1884.

Isopterygium fitzgeraldii (Lesq. et James) Kindb., Enum. Bryin. Exot. 21. 1888. ("*i*")

Plagiothecium fitzgeraldii (Lesq. et James) Ren. et Card., Rev. Bryol. 20: 23. 1893. ("*i*")

Campylium fitzgeraldii (Lesq. et James) Kindb., Can. Rec. Sci. 6(2): 72. 1894. ("*i*")

Campylium striatellum (Brid.) Kindb., Can. Rec. Sci. 6(2): 72. 1894.

Isopterygium striatellum (Brid.) Loeske, Stud. Morph. Syst. Laubm. 168. 1910.

Dolichotheca striatella (Brid.) Loeske, Hedwigia 50: 244. 1911.

Isopterygium pseudo-silesiacum (Lesq. et James) Broth. *in* Engl. et Prantl, Natür. Pflanzenfam. Ed. 2, 11: 462. 1925.

Dolichotheca striatella var. *chrysophylloides* (C. Müll.) Podp., Consp. Musc. Europ. 682. 1954.

Plants in thin to dense mats, yellowish green to dark green, brownish green with age, stems to 2 cm long, 0.5–2.0 mm wide. Stems and branches ascending to erect, branches crowded. Leaves loosely imbricate to somewhat spreading, often squarrose or sometimes squarrose-recurved, usually straight at stem and branch apices, not plicate, 0.6–2.0 × 0.3–0.8 mm, distinctly decurrent; walls of cells at leaf base always distinctly pitted, sometimes pitted to leaf middle or above; median cells 24–50 × 4–7μ; alar cells decurrent, hyaline or sometimes orange to red, abruptly inflated, 14–65 × 14–24μ, rounded to oval, in 2–4 vertical rows of 4–6 cells, extending down stem and terminating at base in a single cell.

Seta 0.9–2.0 cm long; capsule light brown, the urn 1–2 × 0.3–0.5 mm, oblong to cylindric, not or little contracted below mouth; operculum 0.3–0.4 mm long; cilia 1–3.

Habitat. In shaded situations on soil and humus, often on noncalcareous cliffs and rocks, rotten logs, stumps, bases of trees, and exposed tree roots.

Distribution. Not uncommon in the mountains of eastern North America, from Newfoundland and Labrador, south to Georgia and Florida (?), west to Wisconsin, Michigan, Ohio, Kentucky, and Tennessee; rare west of the Rocky Mountains, known from a few collections in Alaska, British Columbia, and Washington; reported from Europe (Map fig. 4).

Illustrations: Plate XI.

Chromosome number: Not reported.

Selected Specimens Examined

EXSICCATI. Austin, Musci Appal. 357 as *Plagiothecium striatellum* (CAN, NY, UBC, US), 358 as *P. striatellum* var. *chrysophylloides* (CAN, DUKE, NY, UBC, US); Drummond, Musci Amer. (Southern States) 111 as *Hypnum silesiacum* (NY); Farlow, Reliquiae Farlowianae 597 as *P. striatellum* (NY, US); Grout, N. Amer. Musci Per. 57 as *P. striatellum* (CAN, DUKE, NY, TENN, UBC, US, WTU), 57a as *P. striatellum* (DUKE); Grout, N. Amer. Musci Pl. 27, 312 as *P. striatellum* (CAN, DUKE, MICH, NY, TENN, US, WTU), 89 as *P. turfaceum* (CAN); Sull. et Lesq., Musci Bor. Amer. (Ed. 1) 353 as *Hypnum muehlenbeckii* (NY, WTU), (Ed. 2) 533 as *H. muehlenbeckii* (CAN, NY).

CANADA. *British Columbia*: Queen Charlotte Islands, Chaatl Island, *Schofield and Boas 18967* (CAN, DUKE, UAC, UBC); Vancouver area, The Lions, *Schofield 19934* (CAN, UBC); Inver Creek, near Skeena, *Schofield and Boas 21684* (CAN). *Labrador*: Battle Harbour, *Waghorne* 7/8/1892 (NY). *Newfoundland*: New Harbour, *Waghorne* in 1891 (CAN). *Nova Scotia*: Cape Breton Island, Indian Brook, *Schofield 6076* (CAN, NY, WTU). *Ontario*: Sudbury District, Katrine Lake, *Cain 2979* (DUKE, TRTC, WTU). *Quebec*: Terrebonne Co., vicinity of Mont Tremblant Lodge, *Crum 9803* (CAN).

U.S.A. *Alaska*: Coronation Island, Egg Harbor, *Foster 2449* (US, WTU); Aleutian Islands, Attu Island, vicinity of Massacre Bay, *Howard 661* (US). *Connecticut*: Windham Co., Central Village, *Sheldon 114* (NY). *Florida*: *Fitzgerald*, no additional information (FH, NY). *Georgia*: Rabun Co., Tallulah Falls, *Small 9312, 9512* (NY). *Kentucky*: McCreary Co., Cumberland Falls, *Ireland 3055* (CAN, DUKE, US). *Maine*: Piscataquis Co., Mount Katahdin, *Hermann 19571* (WTU). *Maryland*: Bank of Youghiogheny River below Swallow Falls, 8 mi. NW. of Oakland, *Hermann 14888* (CAN, NY). *Massachusetts*: Middlesex Co., near Waltham, *Seymour 1279* (TENN, TRTC, US, WTU). *Michigan*: Chippewa Co., Lower Tahquamenon Falls, *Ireland 4348* (US). *Missouri*: St. Louis Co., near St. Louis, collector unknown, in Drummond, *Musci Amer.* (*Southern States*) *111* as *Hypnum silesiacum* (NY). *New Hampshire*: Grafton Co., Franconia Notch, *Stone 409* (WTU). *New Jersey*: Warren Co., along Dunfield Creek near Columbia, *Cowan and Wurdack 181* (NY). *New York*: Hamilton Co., 2 mi. SW. of Long Lake Village, W. shore of Long Lake, *Hermann 14531* (DUKE, NY, US). *North Carolina*: Yancey Co., E. slope of Mount Mitchell, *Anderson 10904* (DUKE). *Ohio*: Jackson Co., Liberty Township, *Bartley and Pontius 171, 266* (NY). *Pennsylvania*: McKean Co., Rutherford, *Burnett 242* (NY). *Tennessee*: Sevier Co., Great Smoky Mountains National Park, Charlie's Bunion, *Schofield 9802* (CAN, UBC). *Vermont*: Windham Co., Newfane, *Wynne 1745* (NY). *Virginia*: Page Co., Shenandoah National Park, Hawksbill Mt., *Ireland 2256* (CAN, DUKE, US). *Washington*: SE. of Verlot, Bear Lake, *Ireland, Lawton, and Sharp 9118* (CAN, WTU). *West Virginia*: Randolph Co., Mingo, *Sharp*, Aug. 13, 1939 (TENN). *Wisconsin*: Columbia Co., The Dells, Aug. 19, 1893, no collector (NY).

The strongly decurrent leaves of *S. striatella* readily distinguish it from the others in the genus. The other *Sharpiella* species have leaves that are not decurrent, or in some instances the leaves are indistinctly decurrent, with one to three marginal cells extending a short distance down the stem.

Grout (1932) regarded *Plagiothecium pseudo-silesiacum* Schimp. *ex* Lesq. et James as a synonym of *S. turfacea*, but an isotype seen at the New York Botanical Garden revealed that the plants had the distinctive inflated, decurrent leaf cells typical of *S. striatella*. I have therefore included it in the synonymy of *S. striatella* since no important differences were found to distinguish the two. Grout (l. c.) did not state where he had seen the "cotype" of *P. pseudo-silesiacum*, but since the moss was distributed as No. 111 in Drummond's *Musci Americani* (*Southern States*), it is possible that some packets of the exsiccatae do contain *S. turfacea*.

The types of two other mosses, *Hypnum fitzgeraldii* Ren. *ex* Lesq. et James, described from North America, and *Plagiothecium muehlenbeckii* B.S.G., described from Europe, were seen and are considered synonyms of *S. striatella* since they fit into its range of variation. Although *H. fitzgeraldii* has been separated from *S. striatella* by its nearly entire leaves, many of the leaves in the type collection are serrate, some of them strongly so.

Hypnum fitzgeraldii was described from material collected by Fitzgerald, presumably in Florida. The label on the holotype at Farlow and on the isotype at the New York Botanical Garden gives "Florida" with no definite locality. Except for the type collection of *H. fitzgeraldii*, no other specimens of *S. striatella* have been seen or reported from Florida, and Breen (1963) does not include it in her flora of the State. Since *S. striatella* is a northern species, occurring only in the mountains of the South Atlantic Coastal States, it seems likely that it does not occur in Florida and that the type of *H. fitzgeraldii* was collected elsewhere. This reasoning is supported by the presence of two mosses that are mixed with *H. fitzgeraldii* in the holotype and are not known to occur in the State. These mosses, *Bartramia pomiformis* Hedw. and *Pohlia cruda* (Hedw.) Lindb., which are more northern in distribution, were first detected in the holotype by Dr. Crum, who called my attention to them. Excluding the one record of *S. striatella* from Florida would make central Georgia the southernmost station for the species.

Sharpiella turfacea (Lindb.) Iwats., J. Hattori Bot. Lab. 28: 203. 1965.

Hypnum turfaceum Lindb., Bot. Notis. 1857: 142. 1857. Type: "Påträffades med fullt utvecklade och ymniga frukter i slutet af Juli månad 1854 i Dalarna vid Grycksbo pappersbruk 1¼ mil n. om Fahlun." Sweden; collector not cited but probably S. O. Lindberg. (Holotype H! Isotype NY!)

Plagiothecium turfaceum (Lindb.) Lindb., Oefv. K. Vet. Ak. Foerh. 14: 124 1858.

Stereodon turfaceus (Lindb.) Mitt., J. Linn. Soc. Bot. 8: 39. 1865.

Isopterygium turfaceum (Lindb.) Lindb., Act. Soc. Fauna et Fl. Fenn. 10: 252, 278. 1872.

Plagiothecium sulcatum Card. et Thér., Bot. Gaz. 37: 378. 1904. Type: "N. Minnesota: on Fall Lake near the foot of Kawasatchong Falls, 11 km, north of Ely (J. M. Holzinger, 1897)." (Holotype PC! Isotype MIN!)

Isopterygium sulcatum (Card. et Thér.) Broth. *in* Engl. et Prantl, Natür. Pflanzenfam. 1(3): 1082. 1908.

Dolichotheca turfacea (Lindb.) Loeske, Hedwigia 50: 244. 1911.

Plants in thin, light green to yellowish green mats, stems to 3 cm long, 1.5–2.5 mm wide. Stems and branches prostrate. Leaves often squarrose-spreading, sometimes erect-spreading, usually appearing distichous and complanate due to twisting of leaves to form two rows on opposite sides of stems and branches, sometimes tips secund at stem and branch apices, smooth or weakly plicate, 1–2 × 0.3–0.7 mm, not decurrent, or 1–3 short cells indistinctly decurrent; walls of cells at leaf base distinctly pitted, indistinctly pitted above,

sometimes pits lacking; median cells 43–80 × 3–6μ; alar cells 14–34 × 9–22μ, quadrate to short-rectangular on margin, sometimes one cell at extreme basal angle rounded to oval and inflated.

Seta 1.2–2.0 cm long; capsule light brown, the urn 0.8–2.0 × 0.3–0.6 mm, oblong to cylindric, contracted under mouth, operculum 0.3–0.4 mm long; cilia 3.

HABITAT. In the mountains or northern regions in open or dense coniferous woods on soil, humus over rock, rotten logs, stumps, and bases of trees; sometimes in bogs, marshes, and swamps, on logs, stumps, and bases of trees.

DISTRIBUTION. Labrador and Newfoundland, south to South Carolina, west to Alberta, Ohio, Illinois, Michigan, Minnesota, South Dakota, and Montana; common in the northern part of its range; reported from Europe and Asia (Map fig. 4).

Illustrations: Plate XII.

Chromosome number: n = 11.

Selected Specimens Examined

EXSICCATI. Austin, Musci Appal. 356 as *Plagiothecium turfaceum* (CAN, NY, UBC, US); Grout, N. Amer. Musci Per. 61 as *P. turfaceum* (CAN, NY, TENN, US, WTU); Grout, N. Amer. Musci Pl. 89 as *P. turfaceum* (NY, TENN, US, WTU), 384 as *P. turfaceum* (CAN, NY, TENN, US, WTU); Macoun, Can. Musci 308 as *Hypnum turfaceum* (CAN, NY, TRTC, US).

CANADA. *Alberta*: Cypress Hills, ½ mi. S. of Elkwater Campsite, Elkwater, *Bird 4389* (UAC). *Labrador*: Grand Lake, Northwest River, *Wickes*, Aug. 4, 1938 (DUKE, NY). *Manitoba*: Lake Winnipegosis, *Macoun*, July 24, 1881 (US, WTU). *New Brunswick*: Victoria-Carleton Co., Tobique River, *Hay*, July 1884 (CAN). *Newfoundland*: Gander Lake, *Tuck M103* (LAWT). *Nova Scotia*: Windsor, *Habeeb 1209* (NY). *Ontario*: Niagara Falls, *Macoun*, July 16, 1901 (CAN, NY, US, WTU). *Prince Edward Island*: Queens Co., Brackley Point, *Macoun*, June 26, 1888 (CAN). *Quebec*: Gaspé Sud, 1 mi. NW. of Percé, *Crum and Williams 10879A* (CAN). *Saskatchewan*: Cypress Hills Provincial Park, S. of Lonepine Campsite, Cypress Hills, *Bird 4740* (UAC).

U.S.A. *Connecticut*: New Haven Co., Woodbridge, *Allen*, Aug. 14, 1880 (NY). *Illinois*: *Vasey*, no additional information (US). *Maine*: Piscataquis Co., 13½ mi. N. of Milo, N. end of Schoodic Lake, *Hermann 19675* (WTU). *Massachusetts*: Berkshire Co., *Reed 48746* (US). *Michigan*: Cheboygan Co., Mud Lake Bog, 6 mi. NE. of University of Michigan Biological Station, *Ireland 4906* (US). *Minnesota*: Clearwater Co., Itasca St. Park, W. side of Garrison Point Bog, *Rosendahl 7307* (NY). *Montana*: Flathead Co., Columbia Falls, *Williams 260* (CAN); Lake McDonald, *Harris 444a* (MONTU). *New Hampshire*: Grafton Co., Grafton, Brighthollow, *Hutchinson*, Sept. 1947 (DUKE, NY, WTU). *New Jersey*: Morris Co., June 1868, locality and collector unknown (NY). *New York*: Hamilton Co., 2 mi. SW. of Long Lake Village, *Hermann 14651* (CAN, DUKE, NY). *North Carolina*: Ravenel Lake, near

Highlands Biological Station, *Ireland 2596* (US). *Ohio*: *Beardslee*, no other data (NY). *Pennsylvania*: Tobyhanna Mills, *Best*, Sept. 13, 1892 (NY). *South Carolina*: Pickens Co., Big Eastatoe Creek, *Correll and Wherry 11006* (DUKE). *South Dakota*: Lawrence Co., Black Hills, Iron Creek, 5 mi. from Spearfish Canyon, *Lawton 1133* (LAWT). *Vermont*: Windham Co., Newfane, *Grout*, Aug. 1903 (DUKE). *Virginia*: Smyth Co., White Top Creek, *Vail and Britton*, June 26, 1892 (NY).

Although no asexual reproductive bodies have been reported for any species of *Sharpiella*, *S. turfacea* may be capable of reproducing vegetatively by detached stem and branch tips. Many stems and branches in some populations have been observed to have an orange or red band about 2–3 mm below the apex. It is in this coloured region that the stem and branch tips are easily detached from the parent plant. Since this type of propagation has not previously been reported for any species in this genus, culture studies are needed to determine if the detached apices are capable of producing new growth.

Sharpiella seligeri (Brid.) Iwats., J. Hattori Bot. Lab. 28: 203. 1965.

Leskea seligeri Brid., Musc. Rec. 2(2): 47. 1801. Type: "In Silesia habitat, ubi a Seligero detecta est." Europe, without collection number or date.

Hypnum serpens var. *repens* Brid., Musc. Rec. 2(2): 114. 1801. Type: "In sylvis circa Lautern Pollichius, et prope Lutetiam Bobartus legerunt."

Hypnum silesianum P. Beauv., Prodromus 70. 1805. (*nom. nud.*)

Hypnum silesianum P. Beauv. *ex* Web. et Mohr, Bot. Tasch. 343. 1807. Type: Apparently based on same type as *Leskea seligeri* Brid.

Hypnum seligeri (Brid.) C. Müll., Syn. Musc. Frond. 2: 259. 1851.

Plagiothecium silesianum (Web. et Mohr) B.S.G., Bryol. Eur. 5: 190. 1851 (fasc. 48 Mon. 12.7). ("*silesiacum*")

Plagiothecium seligeri (Brid.) Lindb., Bot. Notis. 1865: 144. 1865.

Plagiothecium repens (Brid.) Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 9: 36. 1868.

Isopterygium repens (Brid.) Lindb. *ex* Delogne, Flore Crypt. Belgique Pt. 1: 249. 1883.

Isopterygium silesianum (Web. et Mohr) Kindb., Rev. Bryol. 12: 31. 1885. ("*silesiacum*")

Dolichotheca repens (Brid.) Lindb. *ex* Par., Index Bryol. (Ed. 1) 398. 1895.

Dolichotheca seligeri (Brid.) Loeske, Hedwigia 50: 244. 1911.

Dolichotheca silesiana (Web. et Mohr) Fleisch., Musci Fl. Buitenzorg 4: 1378. 1922. ("*silesiaca*")

Isopterygium seligeri (Brid.) Dix. *ex* C. Jens., Skand. Blandmfl. 489. 1939.

Plants in thin, light green to yellowish green mats, stems to 3 cm long, 1.5–3.0 mm wide. Stems and branches prostrate, ascending. Leaves spreading, standing out in all directions at right angles from stems and branches, often with tips secund at stem and branch apices, not plicate, 1.0–2.5 × 0.5–0.9

mm, not decurrent or 1–3 short cells indistinctly decurrent; walls of cells at leaf base distinctly pitted, indistinctly pitted above, sometimes pits lacking; median cells 30–70 × 5–7μ; alar cells 17–48 × 12–26μ, quadrate to short-rectangular on margin, sometimes rounded to oval and inflated.

Seta 1.5–2.5 cm long; capsule light brown to reddish brown, the urn 2.0–3.5 × 0.5–0.8 mm, cylindric, contracted under mouth; operculum 0.4–0.6 mm long; cilia 3.

HABITAT. At low elevations (usually below 3,000 ft.) in coniferous or alder–maple woods on rotten logs and bases of trees.

DISTRIBUTION. Rare or seldom collected in North America, occurring only west of the Rocky Mountains; British Columbia, Washington, Oregon, Idaho, and Montana; reported from Europe, Africa, and Asia (Map fig. 4).

Illustrations: Plate XIII.

Chromosome number: Not reported.

Selected Specimens Examined

EXSICCATI. Allen, Mosses Cascade Mts. Wash. 115 as *Plagiothecium silesiacum* (CAN, DUKE, NY, TENN, UBC, US, WTU).

CANADA. *British Columbia*: Edgewood, *MacFadden 433* (NY); 5 mi. W. of Sicamous, *Bell SB206* (UBC); Nakusp Hot Springs, *Bell SB81* (UBC).

U.S.A. *Idaho*: Kootenai Co., Lake Pend Oreille, *Leiberg 158* (US). *Montana*: Flathead Co., Glacier National Park, Lake McDonald, *Ireland 9555, 9556* (CAN); Lake Co., Flathead Lake, *Schofield 11560, 11915* (UBC). *Oregon*: Wallowa Mountains, between Cove and Minan River, *Sheldon 8976* (NY, US). *Washington*: Clallam Co., Olympic National Park, Boulder Lake Trail, *Ireland 6259* (CAN); King Co., Denny Creek, W. side of Snoqualmie Pass, *Ireland and Lawton 9461* (CAN, WTU); Kittitas Co., ca. 20 mi. NW. of Ronald, along road to Fish Lake, near Salmon la Sac, *Ireland 9488, 9500* (CAN); Stevens Co., Calispell Peak, ca. 20 mi. SE. of Colville, *Ireland 7738* (CAN).

Sharpiella seligeri is closely related to *S. turfacea* and is often difficult to distinguish from it. The differences in phyllotaxy and capsule length used in the key are the only reliable means of separating the two species.

The distribution of the two taxa is distinct in that *S. seligeri* is a northwestern species, while *S. turfacea* is an eastern one. Their ranges overlap in northwestern Montana where *S. turfacea* is rare (known from only two collections), while *S. seligeri* is more common in that region.

Genus **ISOPTERYGIUM** Mitt., J. Linn. Soc. Bot. 12: 21. 1869.

Subgenus *Isopterygium* Grout, Moss Fl. N. Amer. 3: 162. 1932.

Plants glossy, rarely dull, in thin to dense, loose, flat, dark or light green to yellowish green mats. Stems and branches green, yellowish green or sometimes dark red, usually somewhat complanate-foliate, never julaceous, stems simple

or sparingly and irregularly branched, naked or radiculose ventrally; pseudoparaphyllia lacking or present in *I. tenerum*, multicellular, filamentous, of 1 or rarely 2 rows of cells, in clusters on stem around branch primordia and mature branches; cortical stem cells small and thick-walled in cross-section or large and thin-walled in *I. muellerianum*. Stem and branch leaves similar, stiff to soft, imbricate to distant, erect-spreading to squarrose, sometimes secund, flat or concave, smooth or undulate, symmetric or asymmetric, nondecurrent or rarely 1–2 cells indistinctly decurrent, ovate or lanceolate, sometimes cultriform, acuminate, rarely acute or subobtuse; margins plane or recurved, serrulate to strongly serrate above leaf middle, serrate to entire below, sometimes entire throughout; costa short and double, ending a short distance above leaf base, sometimes one branch extending ⅓–½ length of leaf, or costa sometimes lacking; leaf cells smooth or rarely papillose dorsally by projecting cell ends, not pitted or occasionally the walls of basal cells pitted; median cells linear or linear-flexuose; apical cells often short and rhomboidal; basal cells scarcely larger than median cells; alar cells not differentiated, or differentiated and forming a small area of quadrate to rectangular cells, sometimes differentiated only on margins. Asexual reproductive bodies usually present and diverse, sometimes lacking.

Autoicous or dioicous. Perigonia and perichaetia usually numerous on stems. Seta smooth, long, usually twisted, curved or sometimes circinate, brown or reddish brown to dark red. Capsule inclined to cernuous, sometimes erect, rarely pendulous, straight or arcuate when mature; yellow, brown, or red. Urn oblong or ovoid; when dry, smooth or wrinkled, tapering to a wrinkled neck, often contracted under mouth. Operculum conic to short-rostrate, shorter than urn. Annulus lacking or present, usually deciduous, of 2–3 rows of cells, rarely persistent. Peristome perfect, hypnaceous, endostome with 1–3 cilia, shorter than, or approximately the same length as, the segments, or cilia sometimes rudimentary or lacking. Spores globose to ovoid, smooth or minutely papillose, 7–17μ in greatest dimension. Calyptra cucullate, white to yellow, fugacious.

Type species, *Leskea pulchella* Hedw., Sp. Musc. 220. 1801. (Lectotype)

Key to the Species of **Isopterygium**

1. Pseudoparaphyllia present, filamentous, of 1–2 rows of cells; alar cells in marginal row usually quadrate or transversely elongate, often over 12μ wide; asexual reproductive bodies with papillose cells ..... *I. tenerum* p. 48

1. Pseudoparaphyllia lacking; alar cells in marginal row rectangular, seldom quadrate, usually less than 12μ wide; asexual reproductive bodies with smooth cells 2

2. Outer layer of stem cells large and thin-walled in cross-section .. *I. muellerianum* p. 52

2. Outer layers of stem cells small and thick-walled in cross-section 3

3. Leaves symmetric, the apical margins entire or rarely minutely serrulate; costa short and indistinct or often lacking; asexual reproductive bodies rarely present, 2–5 celled cylindric or fusiform broodbodies, small, less than 0.1 mm long; autoicous ..... *I. pulchellum* p. 54

3. Leaves sometimes asymmetric, the apical margins often serrulate to serrate; costa distinct, rarely lacking, often one branch extending ⅓ length of leaf; asexual reproductive bodies common, large, usually more than 0.1 mm long 4

4. Leaves mostly cultriform, seldom symmetric, often undulate; asexual reproductive bodies twisted-vermiform, with 1–5 teeth at apex, rarely any such structures below, commonly borne at or near apices of stems and branches; sexual reproductive structures unknown ..... *I. distichaceum* p. 57

4. Leaves rarely cultriform, mostly symmetric, seldom undulate; asexual reproductive bodies resembling parent plant but smaller, bearing reduced leaves from apex to base of stem, borne throughout stems and branches except at apices; dioicous ..... *I. elegans* p. 60

Isopterygium tenerum (Sw.) Mitt., J. Linn. Soc. Bot. 12: 499. 1869.

Hypnum tenerum Sw., Fl. Ind. Occ. 3: 1817. 1806. Type: "Habitat in truncis arborum Jamaicae montosae." (Holotype? S-PA! Specimen seen in Swartz's Herbarium with no data except no. 2719; Isotype? BM! Specimen collected by Swartz in Jamaica and named *Leskea tenera* Sw.; C! Specimen without locality data but believed to be collected by Swartz.)

Isothecium tenerum (Sw.) Brid., Bryol. Univ. 2: 385. 1827.

Hypnum micans Sw., Adnot. Bot. 175. 1829. Type: "In America septentrionali: Mühlenberg."

Hypnum fulvum Hook. et Wils. *in* Drumm., Musci Amer. (Southern States) 110. 1841. (Later homonym) (*non* Brid. 1801, *nec* (Harv.) C. Müll. 1851). Type: "Louisiana," without additional information in Drummond, Musci Amer. (Southern States) 110. (Isotype NY! WTU!)

Hypnum albulum C. Müll., Syn. Musc. Frond. 2: 280. 1851. Type: "America septentrionalis, in truncis emortuis atque in terra, prope Montgomery Alabamae: Sullivant," in Sullivant, Musci Allegh. 52. (Isotype NY! US!)

Hypnum chapmannii Duby, Flora 58: 285. 1875. ("*i*") Type: "In Florida legit ill. Chapmann (hb. Delessert)." (Holotype G!)

Rhynchostegium micans (Sw.) Aust., Bot. Gaz. 1: 30. 1875.

Isopterygium albulum (C. Müll.) Jaeg. et Sauerb., Ber. St. Gall. Naturw. Ges. 1876–77: 436. 1878.

Plagiothecium chapmannii (Duby) Jaeg. et Sauerb., Ber. St. Gall. Naturw. Ges. 1876–77: 452. 1878. ("*i*")

Plagiothecium fulvum (Hook et Wils.) Jaeg. et Sauerb., Ber. St. Gall. Naturw. Ges. 1876–77: 450. 1878.

Rhynchostegium micans var. *albulum* (C. Müll.) Rau et Herv., Cat. N. Amer. Musci 43. 1880.

Isopterygium micans (Sw.) Kindb., Enum. Bryin. Exot. 21. 1888.

Rhaphidostegium ludovicianum Ren. et Card., Rev. Bryol. 19: 55. 1892. (*nom. nud.*)

Rhaphidostegium micans (Sw.) Ren. et Card., Rev. Bryol. 20: 21. 1893.

Rhaphidostegium micans var. *submersum* Ren. et Card., Rev. Bryol. 20: 21. 1893. Type: "Leg. Langlois," Louisiana, St. Martinsville, A. B. Langlois 879, 9/9/1892. (Holotype? PC!)

Rhaphidostegium ludovicianum Ren. et Card., Rev. Bryol. 20: 21. 1893. Type: "Leg. Langlois," Louisiana, Cloutierville, A. B. Langlois 210, Sept. 27, 1886. (Holotype? PC! Isotype? US!)

Isopterygium fulvum (Hook. et Wils.) Kindb., Can. Rec. Sci. 6(2): 72. 1894.

Plagiothecium micans (Sw.) Par., Index Bryol. (Ed. 1) 963. 1896.

Plagiothecium micans var. *fulvum* (Hook et Wils.) Par., Index Bryol. (Ed. 1) 963. 1896.

Plagiothecium micans var. *submersum* (Ren. et Card.) Par., Index Bryol. (Ed. 1) 963. 1896.

Plagiothecium micans var. *ursorum* (Par.) Par., Index Bryol. (Ed. 1) 963. 1896. (*nom. nud.*)

Hypnum albulum var. *ursorum* Sull. et Lesq. *ex* Par., Index Bryol. (Ed. 1) 963. 1896. (*nom. nud.*)

Plagiothecium albulum (C. Müll.) Kindb., Eur. N. Amer. Bryin. 1: 73. 1897.

Isopterygium ludovicianum (Ren. et Card.) Card. *in* Salm., J. Linn. Soc. Bot. 34: 469. 1900.

Plagiothecium groutii Card. et Thér., Bot. Gaz. 37: 379. 1904. Type: "Delaware: Hampstead, depression in base of a chestnut tree (A. J. Grout, 1899)," locality an error for Hempstead, New York, Dec. 14, 1899. (Holotype PC! Isotype in Grout, N. Amer. Musc. Pl. 196 CAN! DUKE! FSU! NY! WTU!)

Plagiothecium micans var. *latifolium* Grout, N. Amer. Musci Pl. 480. 1922. Type: "Trunk of cypress, Sanford, Florida, S. Rapp, May 1918." (Isotype CAN! FSU! NY! WTU!)

Isopterygium fulvens Williams, The Bryologist 30(2): 32. 1927. (*nom. nud.*)

Isopterygium groutii (Card. et Thér.) Grout, Check List Pl. Moss. N. Amer. 22. 1929.

Plagiothecium micans var. *minus* Grout, Moss Fl. N. Amer. 3(3): 165. 1932. Type: "rotten log, Orange City, Florida, Grout, April, 1911." (Holotype DUKE!)

Plagiothecium micans var. *groutii* (Card. et Thér.) Grout, Moss Fl. N. Amer. 3(3): 165. 1932.

Plagiothecium micans f. *latifolium* (Grout) Grout, Moss Fl. N. Amer. 3(3): 165. 1932.

Isopterygium micans var. *latifolium* (Grout) Schornh., Amer. Mid. Nat. 29: 528. 1943.

Isopterygium fulvum f. *latifolium* (Grout) Crum et Anders., The Bryologist 63(1): 45. 1960.

Isopterygium micans var. *minus* (Grout) Crum et Anders., The Bryologist 63(1): 45. 1960.

Isopterygium micans var. *groutii* (Card. et Thér.) Crum, Steere et Anders., The Bryologist 67(2): 163. 1964.

Isopterygium drummondii Crum, Steere et Anders., The Bryologist 68(4): 434. 1966. Type: Based on same type as *Hypnum fulvum* Hook. et Wils. *in* Drumm.

Plants in thin, light green to yellowishgreen mats, stems to 5 cm long, 0.5–3.0 mm wide. Stems and branches green to yellowish green, usually complanate-foliate, stems often branched, radiculose ventrally; pseudoparaphyllia multicellular, filamentous, of 1 or rarely 2 rows of cells. Leaves erect-spreading, often secund, not plicate, symmetric or often asymmetric, 0.7–1.8 × 0.2–0.6 mm, nondecurrent or rarely 1–2 cells decurrent, ovate, ovate-lanceolate, or lanceolate; margins plane, serrulate to serrate above leaf middle, serrulate to entire below, rarely entire throughout; costa often lacking or short and double, ending a short distance above leaf base; leaf cells smooth; median cells 52–151 × 5–8μ ; alar cells differentiated, forming a small group of short-rectangular to quadrate or often transversely elongate cells, 12–38 × 10–20μ on margin. Asexual reproductive bodies sometimes present, clustered on stems, often over 0.5 mm long, .016–.020 mm wide, uniseriate, filamentous, multicellular, simple or branched, green to brown, the cells papillose.

Autoicous, commonly fruiting. Perichaetia and perigonia numerous, often clumped at stem base; perigonial bracts small, lanceolate to ovate, abruptly acuminate; perichaetial bracts lanceolate to ovate, acuminate to abruptly filiform acuminate. Seta 0.5–1.5 cm long, twisted, sometimes circinate, brown to reddish brown. Capsule cernuous, rarely erect, arcuate or sometimes straight, light brown to orange-brown. Urn 0.5–2.0 × 0.2–0.5 mm, ovoid or sometimes oblong, when dry often strongly contracted for a short distance below mouth, swollen near the wrinkled neck. Operculum conic-apiculate to obliquely rostrate, 0.2–0.4 mm long. Annulus lacking. Cilia 1–3, sometimes rudimentary or lacking.

Habitat. At low elevations in dry wooded regions, in swamps and wet roadside ditches; on rotten logs, stumps, bases of trees, and sandy soil; rarely on sedimentary rock.

Distribution. Common, occurring in the eastern United States from Massachusetts and southern New York, south to Florida, west in the Gulf Coastal States to Texas; also in Kentucky, Missouri, and Arkansas; reported from Mexico, Central and South America, and Asia (Map fig. 5).

Illustrations: Plates XIV and XV.

Chromosome number: n = 12

Selected Specimens Examined

EXSICCATI. Austin, Musci Appal. 427 as *Hypnum micans* (CAN, NY, UBC, US), 428 as *H. micans* var. *fulvum* (CAN, NY, UBC, US), 429 as *H. micans* var. *albulum* (NY, UBC, US); Bauer, Musci Eur. Amer. Ex. 1897,

1898 as *Plagiothecium micans* (NY, WTU); Drummond, Musci Amer. (Southern States) 110 as *H. fulvum* (NY, WTU); Grout, N. Amer. Musci Per. 245 as *P. micans* (CAN, MICH, NY, TENN, WTU), 245a as *P. micans* var. *fulvum* (UBC); Grout, N. Amer. Musci Pl. 196 as *P. groutii* (CAN, NY, WTU); 214 as *P. micans* (CAN, NY, US, WTU), 225 as *P. micans* (CAN, NY, WTU), 274 as *P. micans* var. *fulvum* (CAN, NY, US, WTU), 480 as *P. micans* var. *latifolium* (CAN, FSU, NY, WTU); Sull., Musci Allegh. 52 as *H. subsimplex* (NY, US); Sull. et Lesq., Musci Bor. Amer. (Ed. 1) 448, 449 as *H. albulum* (FH, NY).

U.S.A. *Alabama*: Mobile Co., Mobile, *Mohr*, 1/11/1880 (NY). *Arkansas*: Marion Co., Buffalo River State Park, *Redfearn 15263* (SMS). *Delaware*: Near Milton, *N. L. Britton 73* (NY). *Florida*: Seminole Co., Sanford Jefferson Lake, *Schornherst 1913* (FSU, NY). *Georgia*: Wayne Co., N. of Jesup, Altamaha River Swamp, *Small 5067* (FSU, NY, TRTC). *Kentucky*: Bath Co., S. of Olympian Springs, *Wharton 519* (MICH). *Louisiana*: Iberia Parish, W. side of Weeks Island, *Reese and Harris 1905* (LAF, SMS). *Maryland*: Prince Georges Co., 2¼ mi. W. of Beltsville, E. of Paint Branch, *Hermann 16405* (UBC). *Massachusetts*: Bristol Co., New Bedford, *James* in 1873 (NY, US). *Mississippi*: Jackson Co., Ocean Springs, *Frye*, Aug. 16, 1935 (WTU). *Missouri*: Ozark Co., ca. 3 mi. NW. of Sycamore, *Redfearn 14101* (SMS). *New Jersey*: Atlantic Co., 2 mi. from Weymouth, *Adams*, Sept. 30, 1951 (LAWT). *New York*: Nassau Co., Valley Stream, *Grout 888* (NY). *North Carolina*: Gates Co., ½ mi. E. of Sunbury, *Ireland 4019* (SMS, US). *South Carolina*: Charleston Co., Isle of Palms, *Small*, March 1916 (NY). *Tennessee*: Hardeman Co., Chickasaw State Park. *Clebsch GE108* (TRTC, WTU). *Texas*: Jasper Co., 6 mi. W. of Jasper, *Whitehouse 22592a* (NY). *Virginia*: Nansemond Co., Suffolk, Dismal Swamp, *Vail and Britton*, July 2, 1892 (NY); Norfolk Co., near Wallaceton, Dismal Swamp Canal, *Ireland 3878, 3879, 3883* (US).

Plants named *Isopterygium micans* appear morphologically similar in all important respects to what is believed to be a holotype of *Hypnum tenerum* Sw. at Stockholm and an isotype at the British Museum and Copenhagen. Since *H. tenerum* was described by Swartz in 1806 and since *H. micans* was not described by him until 1829, the former name has priority.

Isopterygium tenerum is predominantly a subtropical–tropical species and is not uncommon in the eastern coastal plain of the United States, extending as far north as Long Island, New York. It is an extremely variable moss, and some taxonomic treatments recognize many infraspecific taxa, all of which are based on doubtfully significant characters. Grout (1932), for example, recognized four infraspecific taxa of *Plagiothecium micans* for North America, distinguished primarily by leaf shape and length. These taxa are the var. *fulvum*, var. *groutii*, var. *minus*, and f. *latifolium*. Redfearn (1956), who made a biometric analysis of the length and shape of the stem leaves of the *P. micans* complex from collections in the southeastern United States, states that "if the subspecific taxa as listed by Grout are biologically distinct, other criteria must be used for their delimitation." After studying *I. tenerum* throughout its range in the United States, including the types of all the infraspecific taxa of *P. micans*, I am unable to find any valid morphological characters to distinguish them.

The existence of unbranched, filamentous pseudoparaphyllia in *I. tenerum* (as *I. micans* var. *fulvum*) was recently reported by Iwatsuki (1963). These pseudoparaphyllia are easily found on the stems and branches, and they were present on all the numerous *I. tenerum* plants examined. The pseudoparaphyllia usually consist of a single row of cells, or rarely of two rows of cells. Large, well-developed plants of *I. tenerum* that grow in subaquatic habitats often have some pseudoparaphyllia of two rows of cells.

There are numerous synonyms for *I. tenerum*, and a critical evaluation of all Mexican and Central and South American species of *Isopterygium* will probably add more. For example, the types of *I. brachyneuron* (C. Müll.) Mitt., *I. cordovense* (C. Müll.) Jaeg. et Sauerb., and *I. fabroniiformis* (C. Müll.) Broth., which were studied from the U.S. National Herbarium, are so similar to *I. tenerum* morphologically that they may have to be reduced to synonymy. It seems advisable not to do so at this time but to await a taxonomic revision of all tropical American species of *Isopterygium*.

Isopterygium muellerianum (Schimp.) Jaeg. et Sauerb., Ber. St. Gall. Naturw. Ges. 1876–77: 441. 1878.

Plagiothecium muellerianum Schimp., Syn. Musc. Eur. (Ed. 1) 584. 1860. Type: "loco rupestri *Campodello* dicto vallis Fassa-Thal in Tyroli meridionali, ubi clar. Joh. Müller genevensis, Resedacearum monographus acutissimus et cui speciem pulcherrimam dedicavi, 30 Sept. 1851 detexit." (Holotype K!)

Hypnum muellerianum (Schimp.) Hook. f., Handb. New Zealand Fl. 476. 1867. ("*mülleri*")

Isopterygium nitidulum ssp. *muellerianum* (Schimp.) Kindb., Can. Rec. Sci. 6(2): 72. 1894. ("*muelleri*")

Plants in thin, yellowish green mats, stems to 2 cm long, 0.8–2.0 mm wide. Stems and branches yellowish green, appearing ventrally concave due to curvature of upturned leaves, simple or irregularly branched, sometimes branches and stem apices stoloniferous, radiculose ventrally; pseudoparaphyllia lacking; outer layer of stem cells large and thin-walled in cross-section. Leaves usually imbricate, erect-spreading, curved upward, appearing distichous, not plicate, rarely a few leaves with some undulations, complanate, symmetric, 0.5–1.5 × 0.2–0.4 mm, nondecurrent, ovate-lanceolate to oblong-lanceolate, usually abruptly short-acuminate; margins plane, entire or minutely serrulate; costa often lacking or short and double; leaf cells smooth; median cells 55–94 × 3–6μ; alar cells differentiated only on margin, 1–3 short-rectangular cells 8–24 × 4–7μ, sometimes not differentiated. Brood-bodies sometimes present, in clusters in leaf axils on stems and branches, .066–.096 × .006–.012 mm, cylindrical or fusiform bodies of 2–6 cells, green to yellowish green, the cells smooth.

Dioicous, rarely fruiting. Perichaetia and perigonia clumped at base of stems and branches; perigonial bracts small, lanceolate to ovate, abruptly acuminate; perichaetial bracts lanceolate to ovate, acuminate. Seta 0.6–1.2 cm long, twisted, brown to reddish brown. Capsule erect, rarely somewhat

cernuous, straight, yellowish brown to orange-brown. Urn 0.5–1.5 × 0.2–0.4 mm, oblong to ovoid, when dry smooth, contracted under mouth. Operculum conic to obliquely rostrate, 0.4–0.8 mm long. Annulus present. Cilia 1–3, sometimes rudimentary or lacking. Spores 8–12μ in greatest dimension.

HABITAT. Mostly in shaded situations on noncalcareous rock, in rock crevices, and on rock outcrops and boulders in woods.

DISTRIBUTION. From Nova Scotia and New Brunswick, south in the mountains to South Carolina and Tennessee; also in Alaska, Michigan, Minnesota, Arkansas, and Missouri; reported from Europe and Asia (Map fig. 7).

Illustrations: Plate XVI.

Chromosome number: Not reported.

Selected Specimens Examined

EXSICCATI. Austin, Musci Appal. 351 as *Plagiothecium muellerianum* (CAN, DUKE, NY, UBC, US); Grout, N. Amer. Musci Pl. 59 as *P. muellerianum* (CAN, DUKE, NY, TENN, US, WTU).

CANADA. *New Brunswick*: North Devon, *Habeeb and Davidson 21* (DUKE). *Nova Scotia*: Kings Co., Cape Blomidon, *Schofield 10936* (CAN). *Ontario*: Nipigon Provincial Forest, 22 mi. N. of Nipigon, *Crum and Anderson 7804* (CAN). *Quebec*: Terrebonne Co., Mont Tremblant Lodge, *Crum and Williams 10288* (CAN).

U.S.A. *Alaska*: Brooks Range, Endicott Mts., SW. end of Chandler Lake, *Steere 18539* (CAN). *Arkansas*: Boston Mts., Spy Rock Hollow, near Cass, *Anderson 12027* (DUKE). *Connecticut*: New Haven Co., Beacon Falls, *Nichols 19* (NY). *Kentucky*: McCreary Co., Cumberland Falls State Park, *Norris*, Feb. 6, 1961 (TENN). *Maine*: Piscataquis Co., 13½ mi. N. of Milo, N. end of Schoodic Lake, *Hermann 19684* (WTU). *Michigan*: Ontonagon Co., Porcupine Mts., near Little Cup Lake, *Nichols and Steere*, Aug. 20–27, 1935 (DUKE). *Minnesota*: Cook Co., 8 mi. SW. of Grand Marais, Cascade River State Park, *Brodo 5898A* (CAN). *Missouri*: Ste. Genevieve Co., Pickle Spring, ca. 6 mi. E. of Farmington on road AA, *Redfearn 13983* (SMS). *New Hampshire*: Grafton Co., Mt. Prospect, vicinity of Plymouth, *Grout*, June 14, 1898 (DUKE). *New Jersey*: Bergen Co., Closter, *Austin 667* (CAN). *New York*: Greene Co., 1 mi. N. of North Lake Campsite, *Ketchledge 1362* (CAN). *North Carolina*: Avery Co., along North Toe River, SW. of Ingalls, *Anderson and Jones 9543* (CAN, DUKE); Macon Co., Crow Creek, 10 mi. NW. of Highlands, *Ireland 2863* (US). *Pennsylvania*: Lancaster Co., Martic Forge, *Porter*, May 1862 (TENN). *South Carolina*: Oconee Co., Whitewater River, above Jocassee, *Anderson 8942* (DUKE). *Tennessee*: Sevier Co., High Spring Bald, *W.B. and M.B. Schofield 9281* (CAN, DUKE, UBC). *Vermont*: Windham Co., Newfane, Upper Baker Brook, *Haring*, Aug. 1, 1936 (NY). *Virginia*: Warren Co., Shenandoah National Park, Overall Run Falls, *Ireland 2469* (CAN).

This species is best distinguished from all other *Isopterygium* species, which were studied from many localities throughout the world, by its stem cells. *Isopterygium muellerianum* always has an epidermal layer of large cells with

thin outer walls and thick inner ones, which are best seen in transverse section. Within the epidermal layer are several layers of small, thick-walled cortical cells, and the centre of the stem is composed of large, thin walled cells. A central strand of small, thin-walled cells may or may not be present. All other *Isopterygium* taxa seen and studied thus far (ca. 94 taxa) have a similar stem morphology except that the epidermal layer is composed of small, thick-walled cells similar to the cortical cells. The distinct stem structure of *I. muellerianum*, which is the same as in all taxa of *Plagiothecium* and *Sharpiella*, is the only important difference between this species and the other members of the genus. However, this single character does not appear to be sufficient reason for establishing a monotypic genus.

Isopterygium pulchellum (Hedw.) Jaeg. et Sauerb., Ber. St. Gall. Naturw. Ges. 1876–77: 441. 1878.

Leskea pulchella Hedw., Sp. Musc. 220. 1801. Type: "In silvis umbrosis Scotiae," no collector cited. (Holotype? G! Specimen seen in Hedwig-Schwaegrichen Herbarium as *Hypnum pulchellum* with illegible writing on sheet.)

Hypnum pulchellum (Hedw.) Brid., Musc. Rec. 2(2): 101. 1801.

Leskea nitida Wahlenb. *ex* Web. et Mohr, Ind. Mus. Pl. Crypt. 3. 1803· (*nom. nud.*)

Hypnum nitidulum Wahlenb., Flor. Lapp. 370. 1812. Type: "in locis deustis supra vegetabilia putrida per Lapponiam subsylvaticam rarius: copiose lectum ad Kaunavaara paroeciae Enontekis."

Hypnum contextum Schleich. *ex* Brid., Bryol. Univ. 2: 454. 1827. (*nom. nud.*)

Plagiothecium nitidulum (Wahlenb.) B.S.G., Bryol. Eur. 5: 188. 1851 (fasc. 48 Mon. 10.5).

Plagiothecium pulchellum (Hedw.) B.S.G., Bryol. Eur. 5: 187. 1851 (fasc. 48 Mon. 9.4).

Hypnum rutilans Wils., Bryol. Brit. 404. 1855. (*nom. nud.*)

Plagiothecium nitidulum var. *suberectum* Lindb., Bot. Notis. 1865: 145. 1865. ("*nitidum*") (*nom. nud.*)

Stereodon geminus Mitt., J. Linn. Soc. Bot. 8: 39. 1865. Type: "Rocky Mountains, alt. 6,000–8,000 feet, associated with *S. pulchellus* and *Mnium umbratile*, Mitten, Lyall." (Holotype NY!)

Stereodon nitidulus (Wahlenb.) Mitt., J. Linn. Soc. Bot. 8: 39. 1865.

Stereodon pulchellus (Hedw.) Mitt., J. Linn. Soc. Bot. 8: 39. 1865.

Hypnum nitidulum var. *suberectum* (Lindb.) Lindb., Oefv. K. Vet. Ak. Foerh. 23: 539. 1867. (*nom. nud.*)

Plagiothecium arnoldii Milde, Bryol. Siles. 318. 1869. ("*i*") Type: "Oberfranken: Am Grunde einer Buche unterhalb der Eustachius-Kapelle zwischen Weitenfurt und dem Schweinsparke bei Eichstätt, im October 1859 mit entdeckelten Kapseln von Arnold entdeckt. -Schlesien: Am Kochelfalle. unter anderen Moosen (Milde); Bunzlau, in Höhlungen der Steinkammern (Limpr.)." (Syntypes, Arnold specimen seen. S-PA!)

Plagiothecium passaicense Aust., Musci Appal. 352. 1870. Type: "Rocky banks, Passaic, Morris and Bergen counties, New Jersey." (Isotype CAN! DUKE! US!)

Plagiothecium nitidulum var. *pulchellum* (Hedw.) Lindb. *ex* Hartm., Skand. Fl. Ed. 10, 2: 24. 1871.

Isopterygium nitidulum (Wahlenb.) Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 13: 416. 1874. ("*nitidum*")

Isopterygium nitidulum var. *suberectum* (Lindb.) Lindb. *ex* Jaeg. et Sauerb., Ber. St. Gall. Naturw. Ges. 1876–77: 442. 1878. ("*nitidum*") (*nom. nud.*)

Plagiothecium geminum (Mitt.) Jaeg. et Sauerb., Ber. St. Gall. Naturw. Ges. 1876–77: 453. 1878.

Isopterygium nitidulum var. *pulchellum* (Hedw.) Lindb., Musc. Scand. 39. 1879. ("*nitidum*")

Plagiothecium pulchellum var. *nitidulum* (Wahlenb.) Rau et Herv., Cat. N. Amer. Musci 43. 1880.

Hypnum passaicense (Aust.) Lesq. et James, Man. Mosses N. Amer. 363. 1884.

Hypnum pulchellum var. *nitidulum* (Wahlenb.) Lesq. et James, Man. Mosses N. Amer. 364. 1884.

Hypnum geminum (Mitt.) Lesq. et James, Man. Mosses N. Amer. 365. 1884.

Isopterygium passaicense (Aust.) Kindb., Enum. Bryin. Exot. 100. 1891.

**Plagiothecium pseudo-latebricolum* Kindb. *in* Mac. et Kindb., Cat. Can. Plants 6: 211. 1892. ("*pseudo-latebricola*") Type: "On rotten wood along the Columbia River, on both sides of the river at Revelstoke, May 3rd and 12th, 1890. (Macoun)." (Syntypes S-PA!)

Isopterygium pseudo-latebricolum (Kindb.) Kindb., Can. Rec. Sci. 6(2): 72. 1894. ("*pseudo-latebricola*")

Isopterygium geminum (Mitt.) Kindb., Can. Rec. Sci. 6(2): 72. 1894.

Isopterygium pulchellum var. *nitidulum* (Wahlenb.) Roth, Eur. Laubm. 2: 594. 1904.

Plagiotheciella passaicensis (Aust.) Fleisch. *ex* Broth. *in* Engl. et Prantl, Natür. Pflanzenfam. Ed. 2, 11: 466. 1925. ("*passaiensis*")

Plants in thin to dense, light green to yellowish green mats, stems to 2 cm long, 1–2 mm wide. Stems and branches yellowish green to green, sometimes red, not usually complanate-foliate, stems simple or branched with numerous short suberect branches, radiculose ventrally; pseudoparaphyllia lacking. Leaves close or often distant, erect-spreading, sometimes secund, often appearing distichous, not plicate, subconcave, symmetric, 0.5–1.5 × 0.2–0.4 mm, nondecurrent, lanceolate to slenderly ovate-lanceolate, gradually long-acuminate; margins plane, entire or sometimes minutely serrulate, often with one cell distinctly serrulate in alar region, rarely two cells; costa often lacking or short

*The "*um*" ending on the specific epithet, which is used here and throughout the revision, is an error. The correct spelling should be *pseudo-latebricola*.

and double, ending a short distance above leaf base; leaf cells smooth, cell walls not pitted; median cells 96–156 × 5–7μ; alar cells differentiated only on margin, 1–3 short-rectangular to quadrate cells, 16–31 × 7–9μ, sometimes not differentiated. Brood-bodies rarely present, in clusters in leaf axils on stems and branches, .033–.060 × .009–.014 mm, uniseriate, cylindrical or fusiform bodies of 2–5 cells, green to yellowish green, the cells smooth.

Autoicous, commonly fruiting. Perichaetia and perigonia numerous, often clumped at stem base; perigonial bracts small, lanceolate to ovate, abruptly acuminate; perichaetial bracts lanceolate to ovate, acuminate to abruptly filiform acuminate. Seta 1–2 cm long, straight or twisted, red to reddish brown. Capsule subcernuous to cernuous, rarely erect, straight to subarcuate, yellow to light brown. Urn 0.5–2.5 × 0.2–0.5 mm, oblong to ovoid, contracted below mouth, smooth, wrinkled at neck when dry. Operculum conic to conic-apiculate, 0.2–0.3 mm long. Annulus present. Cilia 1–3, sometimes rudimentary or lacking.

HABITAT. At high latitudes or in mountainous regions in shaded situations, in cliff crevices, on rocky banks, bases of trees, and decaying wood.

DISTRIBUTION. Not uncommon, from Labrador and Newfoundland, south to Pennsylvania and New Jersey, west in Canada and the northern United States to Alaska, south to California, Idaho, Montana, and Colorado; also in Arizona, South Dakota, Minnesota, and Michigan; reported from Europe, Africa, Asia, and Australia (Map fig. 5).

Illustrations: Plate XVII.

Chromosome number: n = 11 and 22.

Selected Specimens Examined

EXSICCATI. Allen, Mosses Cascade Mts. Wash. 144 as *Plagiothecium pulchellum* (CAN, DUKE, NY, TENN, UBC, US, WTU); Austin, Musci Appal. 352 as *P. passaicense* (CAN, DUKE, US), 354 as *P. pulchellum* (NY, US), 355 as *P. pulchellum* var. *nitidulum* (DUKE, NY, UBC, US); Grout, N. Amer. Musci Per. 454 as *P. pulchellum* (CAN, DUKE, NY, TENN, UBC, US, WTU); Macoun, Can. Musci 304 as *Hypnum latebricola* (CAN, NY, TRTC, US), 306 as *H. pulchellum* (TRTC, US).

CANADA. *Alberta*: Banff National Park, loop trail from Lake Louise Chalet to Lake Agnes, *Ireland 9537, 9538, 9539, 9540* (CAN). *British Columbia*: Salmo District, Wolf Lake Trail, *MacFadden 16873* (CAN, NY, US, WTU); Queen Charlotte Islands, S. Graham Island, Trounce Inlet, *Schofield 15608* (CAN, DUKE, UBC). *Labrador*: Hamilton Inlet, Turner's Head, *Waghorne*, Aug. 8, 1882 (US). *Manitoba*: Gillam, *Crum et al. 115* (CAN). *Newfoundland*: Lark Harbour, *Waghorne*, July 27, 1895 (NY). *Northwest Territories*: King George Islands, Driftwood Island, lat. 57° 17′ N., long. 78° 27′ W., *Taylor 949b* (TRTC). *Nova Scotia*: Cape Breton Island, near Indian Brook, *Nichols 172* (NY). *Ontario*: Nipigon Provincial Forest, 9 mi. N. of Beardmore, *Crum and Anderson 7855* (DUKE). *Quebec*: Gaspesian Park, Gaspé Nord, ca. 8 mi. S. of hotel near Mount Albert, *Crum and Williams 10535* (CAN). *Yukon Territory*: Dawson, *Williams 725* (NY).

U.S.A. *Alaska*: Brooks Range, Franklin Mountains, NW. of Mt. Chamberlin, *Steere 18898* (CAN). *Arizona*: Santa Cruz Co., Patagonia Mountains, Red Mt., *Bartram 957* (NY, US). *California*: Tulare Co. Lower Soldier Lake, *Howell*, July 23, 1949 (NY). *Colorado*: Swamp above Beaver Creek, *Crandall*, July 7, 1896 (NY). *Idaho*: Kootenai Co., Lake Pend Oreille, *Leiberg 217* (NY). *Maine*: Somerset Co., Fairfield, *Allen*, July 7, 1877 (NY). *Michigan*: Cheboygan Co., Hermit's Bog, near University of Michigan Biological Station, *Ireland 4451* (CAN, TENN, UMBS, US). *Minnesota*: St. Louis Co., Duluth, *Shultz* in 1897 (NY). *Montana*: Flathead Co., Glacier National Park, 4 mi. NE. of Avalanche Creek Campground Entrance, *Ireland 9552* (CAN). *New Hampshire*: Coos Co., base of Mt. Washington, *Allen*, Aug. 8, 1878 (NY). *New Jersey*: Bergen Co., Closter, *Austin* in 1890's (US). *New York*: Washington Co., Fort Edward, *Howe s. n.*, no date (NY). *Oregon*: Union Co., Wallowa Mountains, between Cove and the Nunain River, *Sheldon 8977* (NY, US). *Pennsylvania*: Elk Co., Benezett, *McMinn*, Oct. 1868 (TENN). *South Dakota*: Lawrence Co., Ice Box Canyon, *Conard*, Aug. 30, 1953 (LAWT). *Vermont*: Windham Co., Newfane, *Grout*, Aug. 22, 1904 (NY). *Washington*: Jefferson Co., Olympic National Park, trail to Lake Constance, *Ireland 6474* (CAN). *Wyoming*: Teton Co., Yellowstone National Park, Lower Geyser Basin, *Rydberg and Bessey*, June–Aug. 14, 1897 (NY).

The var. *nitidulum*, a doubtfully valid segregate of *I. pulchellum* recognized by Grout (1932), is frequently found in the Rocky Mountain region of North America. Several insignificant gametophytic characters have been used to distinguish it; namely, the straggling tufts with stoloniferous stems; the spreading to nearly prostrate, plainly complanate-foliate branches; the robust size; and the long, slenderly acuminate leaves with the apical margins sometimes denticulate. Because all these characters are extremely variable and do not always correlate with each other, I do not feel the var. *nitidulum* is worth formal recognition.

The types of *Plagiothecium arnoldii* Milde, *P. passaicense* Aust., and *P. pseudo-latebricolum* Kindb. *in* Mac. et Kindb. were examined and are considered synonyms of *I. pulchellum*, since no important differences were detected.

Isopterygium distichaceum (Mitt.) Jaeg. et Sauerb., Ber. St. Gall. Naturw. Ges. 1876–77: 439. 1878.

Stereodon distichaceus Mitt., J. Linn. Soc. Bot. Suppl. 1: 105. 1859. Type: "In Nepal, Wallich! In Himalaya boreali-occident., Royle!" (Syntype specimen seen collected by Wallich in Nepal, India. NY!)

Plagiothecium subfalcatum Aust., Musci Appal. 366. 1870. Type: "Crevices of rocks among the mountains of New Jersey and New York (Austin); Pennsylvania, James." (Isotype CAN! DUKE! NY! US!)

Isopterygium subfalcatum (Aust.) Jaeg. et Sauerb., Ber. St. Gall. Naturw. Ges. 1876–77: 438. 1878.

Plagiothecium elegans var. *subfalcatum* (Aust.) Rau et Herv., Cat. N. Amer. Musci 43. 1880.

Hypnum subfalcatum (Aust.) Lesq. et James, Man. Mosses N. Amer. 371. 1884.

Isopterygium poasense Ren. et Card., Bull. Soc. Roy. Bot. Belg. 41: 141. 1905. Type: "Potrero del Alto (2460 m.), massif du volcan de Poas (Pitt. no. 5791)," Costa Rica, H. Pittier, July 20, 1888, distributed in Plantae costaricenses exsiccatae 5791. (Isotype US!)

Taxiphyllum howellianum Crum et Anders., J. Elisha Mitchell Sci. Soc. 74: 38. 1958. Type: "On soil, hemlock-hardwood forest, alt. 3800 ft., Howell Tract, below Cowee Gap, west of Cashiers, Jackson Co., North Carolina, Lewis E. Anderson 11071, July 28, 1952." (Isotype CAN!)

Plants in thin, light green to yellowish green mats, stems to 2.5 cm long, 1–3 mm wide. Stems and branches yellow to green, rarely brown or red, often complanate-foliate, stems simple or branched, naked ventrally; pseudoparaphyllia lacking. Leaves distant or sometimes close, usually squarrose or nearly so, imbricate near stem and branch tips, apices sometimes pointing toward substratum, subcomplanate to complanate, often strongly undulate, usually asymmetric or sometimes symmetric, 0.3–1.8 × 0.2–0.6 mm, nondecurrent, often cultriform, ovate-lanceolate or oblong-lanceolate, acuminate or abruptly narrowed to an acute apex; margins plane or often recurved at base, serrulate to serrate in upper half of leaf, often strongly serrate near apex, serrulate to entire below; costa short and double, sometimes one branch extending ⅓ length of leaf, rarely lacking; leaf cells smooth or often papillose dorsally by projecting cell ends in apical region, cell walls not pitted; median cells 48–100 × 4–7μ; alar cells not differentiated or sometimes 1–3 marginal cells rectangular to quadrate, 10–31 × 7–12μ. Propagula common, usually clustered in leaf axils at or near stem and branch apices, 0.1–0.5 mm long, yellowish green, elongated, twisted-vermiform, composed of 2–4 layers of smooth cells, with 1–5 acute, erect teeth-like structures at apex, rarely any such structures present below.

Capsules and sex organs not seen in North American collections.

Habitat. In shaded situations usually in mountainous regions (up to 4,000 ft.) on soil, humus banks, sandstone bluffs, and frequently on cliff ledges containing mica.

Distribution. Not uncommon in the eastern United States, from Maine south to Tennessee and South Carolina; also in Ontario, Ohio, Illinois, Michigan, Arkansas, and Missouri; in Central America and Asia (Map fig. 6).

Illustrations: Plate XVIII.

Chromosome number: Not reported.

Selected Specimens Examined

EXSICCATI. Austin, Musci Appal. 343 as *Rhynchostegium depressum* (NY), 366 as *Plagiothecium subfalcatum* (CAN, DUKE, NY, US).

CANADA. *Ontario*: Cattle Island, Lake Timagami, *Cain 2691* (TRTC).

U.S.A. *Arkansas*: Franklin Co., Boston Mountains, near Cass, Spy Rock Hollow, *Anderson 12062* (DUKE). *Illinois*: Jackson Co., Giant City State Park, *Redfearn 20339* (CAN). *Maine*: Piscataquis Co., E. slope of Mt. Katahdin,

Chimney Pond Trail, *Hermann 19240* (CAN, US). *Maryland*: 9 mi. NW. of Snow Hill, *Reese 7389* (CAN, LAF). *Michigan*: Chippewa Co., Tahquamenon Falls State Park, Lower Tahquamenon Falls, *Ireland 4347* (US). *Missouri*: Ste. Genevieve Co., ca. 6 mi. E. of Farmington, Pickle Spring, *Redfearn 13756, 13764* (SMS). *New Jersey: Austin*, no other data (CAN). *New York*: Essex Co., N. slope of Whiteface Mt., *Redfearn 13405* (SMS). *North Carolina*: Stokes Co., Moore's Springs, *Anderson 6245* (TENN, TRTC); Transylvania Co., 8 mi. SW. of Rosman, Toxaway Creek, *Anderson 11090* (DUKE). *Ohio*: Jackson Co., Liberty Township, *Bartley and Pontius 106* (NY). *Pennsylvania*: Somerset Co., Beck Spring, Laurel Ridge, *Boardman*, July 26, 1947 (CM). *South Carolina*: Oconee Co., Jocassee, *Schofield, Robinson and Clebsch 11104* (UBC). *Tennessee*: Sevier Co., Great Smoky Mountains National Park, near Siler's Bald, *Schofield 9428* (CAN, DUKE). *Vermont*: Windham Co., Haystack Mt., *Wynne 1983* (NY). *Virginia*: Giles Co., Mountain Lake Biological Station, path to Little Stony, *Blomquist 3422* (DUKE). *West Virginia*: Tucker Co., Blackwater Fork of Cheat River, *J. D. Smith*, July 1878 (US).

Isopterygium distichaceum from Asia has been a poorly understood species, and it was only recently that Dr. Iwatsuki (pers. comm.) called my attention to the similarity between it and *I. subfalcatum* from eastern North America. An examination of the types of both species failed to reveal any important differences; therefore the name *I. distichaceum* antedates the name *I. subfalcatum* by several years. The types of *I. poasense* Ren. et Card. from Costa Rica and *Taxiphyllum howellianum* Crum et Anders. from North Carolina, which were also examined, could not be distinguished from *I. distichaceum* and should be considered synonymous with it. Both collections have propagula near the stem and branch apices that are identical with those of *I. distichaceum*. Although many leaves in the type of *T. howellianum* are strongly undulate, as noted in the description, this is a variable character, along with other variable features of *I. distichaceum*, such as leaf shape, serrations of leaf apices, and papillae on the cells of the dorsal leaf surface.

After a critical examination of specimens named *I. elegans* (Brid.) Lindb., a clearer picture of the distribution of *I. distichaceum* has been obtained. Many of the eastern North American specimens were found to be misidentified *I. distichaceum*, which they closely resemble. It is now apparent that *I. distichaceum* is not so rare as it was once considered, but rather it is now known from a wide area in the eastern United States and Canada, reaching as far south as Costa Rica.

A detailed study of the closely related Asiatic species *I. fauriei* Card., *I. pohliacarpum* (Sull. et Lesq.) Mitt., and *I. tosaense* Broth., and a comparison with *I. distichaceum* are desirable because all four taxa have the same type of propagula and appear similar in many other respects. The peculiar red pigmentation of the leaves on many of the Asiatic plants in this species complex was only rarely noted in the North American specimens. Also, while many of the Asian specimens were found to be autoicous, often possessing sex organs and capsules, none of the plants from North America were ever seen with sex organs or capsules.

Isopterygium elegans (Brid.) Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 13: 416. 1874.

Isothecium elegans Brid., Bryol. Univ. 2: 356. 1827. Type: Based on type of *Hypnum elegans* Hook.

Hypnum elegans Hook., Musci Exot. 1: Pl. 9. 1818. (Later homonym) (*non* Ehrh. *ex* Brid. 1801, *nec* Dill. *ex* Brid. 1801) Type: "Apud Nootka, in plaga occidentali Americae Borealis, legit D. Menzies, 1787," British Columbia, Vancouver I., no. 35. (Holotype K! Isotype NY!)

Hypnum planifolium Brid., Bryol. Univ. 2: 411. 1827. (Later homonym) (*non* (Hedw.) P. Beauv. 1805, *nec* (Hedw.) Poir. *ex* Brid. 1827) Type: "In Normandia circa Falaise ad terram habitat," France, no collector, number, or date cited.

Hypnum borrerianum Spruce *ex* C. Müll., Syn. Musc. Frond. 2: 279. 1851. Type: "In zona montosa et subalpina Pyrenaeorum centralium pr. Bagnères-de-Bigorre, ad terram (♀); Bois de Sajust prope Bagnères-de-Luchon, ad rupes graniticas (♀ et ♂): Spruce; ad rupes arenaceas Angliae, in Eridge Park, Tunbridge Wells, in vicinia Castle-Haward, in Eskdale: Spruce, Borrer, Wilson, Mitten, prope Bantry fertile legit Miss Hutchins." (Syntypes, W. Borrer, May 1845; R. Spruce, April 1846; W. Mitten, April 1848 specimens seen from Tunbridge Wells. BM!)

Hypnum collinum Wils., Bryol. Brit. 408. 1855. (*nom. nud.*)

Hypnum elegans var. *collinum* Wils., Bryol. Brit. 408. 1855. Type: "on Congleton Cloud, Alderley Edge, and Frodsham Rocks, Cheshire, W. Wilson." (Syntypes BM!)

Plagiothecium denticulatum var. *densum* Saut. *ex* Rabenh., Bryoth. Eur. 390. 1861. (*nom. nud.*) (*non* B.S.G. 1851)

Plagiothecium schimperi Jur. et Milde *ex* Rabenh., Bryoth. Eur. 588. 1861. (*nom. nud.*)

Plagiothecium schimperi Jur. et Milde *ex* Jur., Verh. Zool.-Bot. Ges. Wien 12(2): 968. 1862. Type: "Solo arenaceo in fagetis et pinetis prope Juvaviam leg. Dr. Sauter (*Plagioth. denticulatum* var. δ *densum* in Bryotheca europaea Heft. VII. Nr. 390); ad terram in silvis montis Plöckenstein Austriae superioris (Dr. J. S. Poetsch), prope Warstein Borussiae rhenanae (Dr. H. Müller), prope Schenpfenthal Thuringiae (A. Röse), denique im kleinen Zackenthal Sudetorum, ubi pulchra specimina legit am Dr. Milde." (Syntypes, Sauter specimen from around Salzburg seen in Rabenhorst's Bryoth. Eur. 390. NY!)

Rhynchostegium elegans (Brid.) Lindb., Hedwigia 2: 79. 1863.

Rhynchostegium elegans var. *terrestre* Lindb., Bot. Notis. 1865: 139. 1865. Type: Apparently based on same type as *Plagiothecium schimperi* Jur. et Milde *ex* Jur.

Rhynchostegium elegans var. *collinum* (Wils.) Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 9: 38. 1868.

Plagiothecium elegans var. *gracilens* Aust., Musci Appal. 350. 1870. (*nom. nud.*)

Isopterygium borrerianum (C. Müll.) Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 13: 416. 1874. ("*borreri*")

Plagiothecium elegans (Brid.) Schimp., Syn. Musc. Eur. (Ed. 2) 697. 1876.

Plagiothecium elegans var. *schimperi* (Jur. et Milde) Limpr., Krypt. Schles. 1: 83. 1876.

Plagiothecium borrerianum (C. Müll.) Spruce, J. Bot. 18: 290. 1880.

Plagiothecium elegans var. *gracilis* Rau et Herv., Cat. N. Amer. Musci 43. 1880. (*nom. nud.*)

Plagiothecium elegans var. *terrestre* (Lindb.) Rau et Herv., Cat. N. Amer. Musci 43. 1880. ("*terrestris*")

Isopterygium elegans var. *schimperi* (Jur. et Milde) Limpr. *ex* Delogne, Flore Crypt. Belgique Pt. 1: 249. 1883.

Hypnum elegans var. *terrestre* (Lindb.) Lesq. et James, Man. Mosses N. Amer. 366. 1884.

Plagiothecium borrerianum var. *collinum* (Wils.) Dix. et Jameson, Stud. Handb. Brit. Moss. 432. 1896.

Plagiothecium elegans var. *gracilens* Aust. *ex* Grout, Moss Fl. N. Amer. 3(3): 164. 1932. Type: "Crevices of rocks, near Suffern, New York; sterile," in Austin, Musci Appal. 350. (Isotype DUKE!, NY! UBC! US!)

Isopterygium elegans var. *terrestre* (Lindb.) Wijk et Marg., Taxon 11(7): 221. 1962.

Isopterygium borrerianum var. *gracilens* (Grout) Crum, Steere et Anders., The Bryologist 68(4): 433. 1966.

Isopterygium borrerianum var. *terrestre* (Lindb.) Crum, Steere et Anders., The Bryologist 68(4): 433. 1966.

Plants in thin to dense, dark or light green to yellowish green mats, stems to 3.5 cm long, 1.0–2.5 mm wide. Stems and branches mostly dark red when mature, sometimes green or yellowish green, usually somewhat complanate-foliate, stems often irregularly branched, naked ventrally; pseudoparaphyllia lacking. Leaves distant, erect-spreading or sometimes secund with apices pointing toward substratum, smooth to weakly undulate, appearing distichous but in more than two rows, symmetric or rarely somewhat asymmetric, 0.3–2.0 × 0.2–0.7 mm, nondecurrent, lanceolate, ovate-lanceolate or sometimes oblong-lanceolate, acuminate; margins plane, serrulate to strongly serrate in upper half, serrulate to entire below; costa short and double, sometimes one branch extending ⅓ length of leaf, rarely lacking; leaf cells smooth or rarely subpapillose dorsally by projecting cell ends in apical region; median cells 48–100 × 4–7μ; alar cells not differentiated or 1–3 marginal cells rectangular to quadrate, 10–31 × 7–10μ. Propagula common, clustered in leaf axils except at or near the apices of stems and branches, 0.5–1.5 mm long, resembling the parent plant but smaller, bearing reduced leaves from apex to base of stem, yellow to green, the cells smooth.

Dioicous, frequently fruiting. Perigonia numerous along stems, the bracts large, ovate, abruptly acuminate. Perichaetia few, at bases of stems, the bracts lanceolate to ovate, acuminate to abruptly filiform-acuminate. Seta 1.0–2.5 cm long, twisted, sometimes circinate, dark red. Capsule cernuous to pendulous, straight or subarcuate, dark brown to dark red. Urn 1–2 × 0.3–0.5 mm, oblong-ovoid to ovoid, wrinkled and contracted below mouth when dry, wrinkled only at neck when operculate. Operculum conic to short-rostrate, 0.4–0.7 mm long. Annulus present. Cilia 2–3.

HABITAT. In shaded areas at low or high elevations on noncalcareous rock and soil, humus, bases of trees, and rotten logs.

DISTRIBUTION. Uncommon in the East, from Newfoundland south to Georgia, South Carolina, Tennessee, Arkansas, and Missouri; common in the West in Alaska, Aleutian Islands, British Columbia, Washington, Oregon, and California; reported from Europe, Africa, and Asia (Map fig. 6).

Illustrations: Plate XIX.

Chromosome number: n = 11.

Selected Specimens Examined

EXSICCATI. Allen, Mosses Cascade Mts. Wash. 145 as *Plagiothecium elegans* (CAN, DUKE, NY, TENN, UBC, US, WTU); Austin, Musci Appal. 348 as *P. elegans* (DUKE, NY, UBC, US), 349 as *P. elegans* var. *terrestre* (DUKE, NY, UBC, US), 350 as *P. elegans* var. *gracilens* (DUKE, NY, UBC, US); Grout, N. Amer. Musci Pl. 143 as *P. elegans* (CAN, NY, TENN, US, WTU), 322 as *P. elegans* (CAN, DUKE, NY, TENN, US, WTU); Macoun, Can. Musci 309 as *Hypnum elegans* (NY, TRTC, US).

CANADA. *British Columbia*: Vancouver Island, near Victoria, *Macoun*, May 3, 1887 (NY, US); Queen Charlotte Islands, Moresby Island, Peel Inlet, *Schofield 15317* (DUKE, UBC). *Newfoundland*: Long Beach, *Waghorne*, April 28, 1895 (NY). *Nova Scotia*: Guys Co., near Point Mulgrave, Hartley's Falls, *Prince 6563* (DUKE). *Ontario*: Nipigon Provincial Forest, Nipigon, Lake Helen, *Crum and Anderson 7703* (DUKE). *Quebec*: Gatineau Hills, vicinity of Kingsmere and Old Chelsea, *Crum 2935* (WTU).

U.S.A. *Alaska*: Zarembo Island, St. John Harbor, *Frye*, June 1, 1913 (WTU); Aleutian Islands, Attu Island, *Howard 233*, *284a*, *334*, *842b* (US). *Arkansas*: Newton Co., Boston Mountains, 8 mi. NW. of Boxley, *Anderson 12119* (DUKE). *California*: Marin Co., slope of Mount Tamalpais, *Koch 2263* (NY). *Connecticut*: Litchfield Co., Salisbury, *Nichols 79* (NY). *Georgia*: Macon Co., Rabun Bald, *Steere 10142* (MICH). *Illinois*: Pope Co., Bell Smith Recreation Area, *Sharp I-621* (TENN). *Indiana*: Warren Co., ca. 13 mi. SW. of Lafayette, Little Pine Creek Gorge, near High Bridge, *Ireland 5399* (DPU, US). *Kentucky*: McCreary Co., Cumberland State Park, W. side of Cumberland Falls, *Ireland 3019* (US). *Maine*: Hancock Co., Ellsworth, *Morse*, Sept. 22, 1935 (NY, WTU). *Maryland*: Prince Georges Co., Bladensburg, *Leonard 18281*, *18610*, *19311*, *19336*, *19357*, *19371* (US). *Michigan*: Alger Co., Scott Falls, *Wynne 1079* (NY). *Missouri*: Shannon Co., ca. 10 mi. SE. of Eminence, *Redfearn 8418* (SMS).

New Hampshire: Grafton Co., Mt. Cardigan, Wildcat Gorge Brook, *Hutchinson*, Oct. 15, 1950 (DUKE). *New Jersey*: Near Pascack (Passaic?), *Austin* in Austin, *Musci Appal. 349* (DUKE, NY, UBC, US). *New York*: Fulton Co., Pine Lake, *Ketchledge 830* (NY). *North Carolina*: Mitchell Co., Cherokee National Park, Roan Mt., Roan High Bluff, *Ireland 1536* (CAN, US). *Ohio*: Jackson Co., Liberty Township, *Bartley and Pontius 74, 133, 260* (NY). *Oregon*: Curry Co., Redwood State Park, 8 mi. E. of Brooking, *Koch 3234a* (NY, US). *Pennsylvania*: Carbon Co., Glen Onoko, *Wolle*, July 1873 (US). *South Carolina*: Oconee Co., *Anderson 8509* (US). *Tennessee*: Sevier Co., Great Smoky Mountains National Park, Newfound Gap, *Schofield 9737* (UBC). *Vermont*: Windham Co., Haystack Mt., *Wynne 2012* (NY). *Virginia*: Warren Co., Shenandoah National Park, Overall Run Trail, *Ireland 2455, 2477* (US). *Washington*: Clallam Co., Olympic National Park, trail to Deer Lake, *Ireland 6812* (CAN). *West Virginia*: Taylor Co., near Grafton, *Boutlou 341* (DUKE).

Two varieties of *I. elegans* are often recognized for North America, namely var. *gracilens* and var. *terrestre* (var. *schimperi*). The former is distinguished by its small size, the latter by its robust size and secund leaves. After a thorough study of the species over its entire range, however, neither variety seems worthy of taxonomic recognition since size and leaf curvature vary and do not correlate with other characters. Lefebvre (1963), who made a detailed morphological study of the leaves of var. *terrestre* (as *I. elegans* var. *schimperi*) in Belgium, also concluded that it should not be maintained as a distinct variety.

The type of asexual reproductive bodies produced by *I. elegans* is different from any other known species in the genus *Isopterygium*. They resemble the parent plant, but they are much smaller, commonly being less than 1.5 mm long. Twisted vermiform propagula that are somewhat similar are produced by *I. distichaceum* and several Asiatic species (e.g., *I. fauriei* Card., *I. pohliacarpum* (Sull. et Lesq.) Mitt., and *I. tosaense* Broth.). The morphologically distinct asexual reproductive bodies, together with their position on the plant, provide the most reliable means of distinguishing *I. elegans* from the closely related *I. distichaceum*.

Genus **Taxiphyllum** Fleisch., Musci Fl. Buitenzorg 4: 1434. 1922.

Subgenus *Taxiphyllum* (Fleisch.) Grout, Moss Fl. N. Amer. 3(3): 161. 1932.

Plants glossy, rarely dull, sometimes with an oily sheen, in thin to dense, loose, flat, green to yellowish green or yellowish brown mats, sometimes brownish green with age. Stems and branches green or yellowish green, complanate-foliate, rarely julaceous or subjulaceous, stems simple or sparingly and irregularly branched, naked or radiculose ventrally; pseudoparaphyllia always present, large, foliose, lanceolate, in clusters on stem around branch primordia and mature branches; cortical stem cells small and thick-walled in cross-section. Stem and branch leaves similar, stiff to soft, imbricate to distant, erect-spreading to squarrose, never secund, flat or concave, smooth or rarely plicate, symmetric or asymmetric, nondecurrent, ovate, ovate-lanceolate, or oblong-lanceolate, acuminate, rarely acute or subobtuse; margins plane or recurved, serrulate to serrate above leaf middle, serrulate to entire below; costa short and double, ending a short distance above leaf base, sometimes one branch

extending ⅓–½ length of leaf, or costa sometimes lacking; leaf cells smooth or rarely papillose dorsally by projecting cell ends, walls not pitted; median cells linear or linear-flexuose; apical cells often short and rhomboidal; basal cells scarcely larger than median cells; alar cells quadrate to rectangular, often in 1–several rows with 1–12 cells in marginal row. Asexual reproductive bodies unknown.

Dioicous, rarely fruiting. Perigonia rarely present; perichaetia numerous on stems and branches. Seta smooth, long, usually twisted and curved, yellowish brown, turning red with age. Capsule cernuous, straight or arcuate when mature, yellowish brown to reddish brown. Urn oblong or ovoid; when dry, smooth or wrinkled; tapering to a wrinkled neck; often contracted under mouth. Operculum obliquely rostrate, 0.5–1.0 mm long. Annulus persistent, comprising 2 rows of cells. Peristome perfect, hypnaceous, endostome with 2–3 cilia, shorter than, or approximately the same length as, the segments. Spores globose to ovoid, smooth or minutely papillose, 7–17 μ in greatest dimension. Calyptra cucullate, white to yellow, fugacious.

Type species, *Hypnum deplanatum* Bruch et Schimp. *ex* Sull. *in* Gray, Man. Bot. N. U. States 670. 1848.

Key to the Species of **Taxiphyllum**

1. Plants julaceous to subjulaceous; quadrate to short-rectangular alar cells numerous, often with 6–12 in marginal row ..... *T. cuspidifolium* p. 64

1. Plants complanate-foliate, leaves often appearing distichous; quadrate to short-rectangular alar cells few, usually less than 6 in marginal row 2

2. Leaves close, appressed-imbricate, never squarrose; margins usually plane or rarely recurved at base, 3–8 quadrate alar cells nearly always present in marginal row ..... *T. deplanatum* p. 66

2. Leaves distant or if imbricate not appressed, often squarrose; margins usually recurved to middle of leaf, sometimes plane; quadrate cells often lacking in marginal row 3

3. Leaves broadly ovate-lanceolate, often over 1 mm wide near middle, apex often acuminate and twisted; margins plane, rarely recurved; leaf cells smooth ..... *T. alternans* p. 69

3. Leaves narrowly oblong-lanceolate or ovate-lanceolate, rarely over 1 mm wide near middle, apex often acute to subobtuse, seldom acuminate, not twisted; margins usually narrowly recurved to middle of leaf; leaf cells sometimes dorsally papillose by projecting cell ends *T. taxirameum* p. 70

Taxiphyllum cuspidifolium (Card.) Iwats., J. Hattori Bot. Lab. 28: 220. 1965.

Isopterygium cuspidifolium Card., Bull. Soc. Bot. Genève 4 (sér. 2): 387. 1912. Type: "Japon: Sobosan (n. 842)," collected by U. Faurie in Kyusyu, Japan.

Plagiothecium squamatum Broth., Övers. Finska Vet.-Soc. Förhandl. 62: 45. 1921. Type: "Kiushiu. Nagasaki; ad terram (Sh. Okamura 1012)," collected in Japan, Prov. Thizen, April 16, 1911. (Holotype H!)

Plagiothecium mariannae Grout, Moss Fl. N. Amer. 2(4): 272. 1940. Type: "near Marianna Caves, Jackson Co., Florida, Nov. 16, 1939 (A. J. Grout and Ruth Olive Schornherst)," Schornherst 1442. (Holotype FSU! Isotype DUKE! TENN!)

Taxiphyllum mariannae (Grout) Schornh., Amer. Mid. Nat. 29: 528. 1943.

Taxiphyllum squamatum (Broth.) Iwats., J. Hattori Bot. Lab. 26: 67. 1963.

Plants in thin, dark green to yellowish green mats, with an oily sheen when wet; stems to 3 cm long, 1–3 mm wide. Stems and branches julaceous to subjulaceous, rarely complanate-foliate, stems usually simple, often radiculose ventrally. Leaves loosely imbricate, usually concave, not plicate, symmetric, 1.0–2.5 mm long, 0.5–1.0 mm wide near leaf middle, 0.2–0.4 mm wide at base, ovate to broadly ovate-lanceolate, acuminate or filiform-acuminate, often twisted at apex; margins plane, serrulate to serrate above leaf middle, serrulate to entire below; costa short and double, one branch extending ⅓–½ length of leaf, rarely lacking; leaf cells smooth; median cells linear-flexuose, 75–120 × 7–12μ, becoming rhomboidal near apex and base; alar cells 12–48 × 10–22μ, quadrate to rectangular, in 2–several rows with 5–12 cells in marginal row.

Reported as dioicous. Perigonia not seen; perichaetia large, numerous, bracts lanceolate to ovate-lanceolate, acuminate to abruptly acuminate. Sporophytes unknown in North America.

Habitat. At low elevations on calcareous soil and rock, rarely over exposed tree roots.

Distribution. Rare, known from Tennessee, Alabama, and Florida; reported from Asia (Map fig. 8).

Illustrations: Plate XX.

Chromosome number: Not reported.

Specimens Examined

U.S.A. *Alabama*: Bibb Co., near Pratt's Ferry, *Harper 35* (NY, US). *Florida*: Alachua Co., Buzzard's Roost, 8 mi. W. of Gainesville, *Anderson and Crum 13286* (CAN, DUKE); Citrus Co., near Pineola, *Redfearn 1526* (SMS); Citrus Co., 1 mi. E. of Pineola, *Redfearn 1730* (FSU, SMS, TENN); Jackson Co., Marianna Caverns, *Schornherst 1495*, *1727*, *1728*, *1729*, *2464* (FSU), *1505* (FSU, NY), *1663*, *1664* (FSU, DUKE); Jackson Co., Florida Caverns State Park, ca. 2 mi. W. of Marianna, *Pursell 300MF7* (SMS); Jackson Co., Florida Caverns State Park, Marianna, *Anderson and Crum* 13677 (DUKE). *Tennessee*: Anderson Co., Savage-Brown Garden, near Lake City, *Iwatsuki 210351* (TENN); Montgomery Co., near Seven Mile Island, 3 mi. SE. of Clarksville, *Clebsch 699* (NY, TRTC, WTU).

This julaceous, calcicolous species was collected at the Marianna Caverns in Jackson County, Florida, and described as a new species, *Plagiothecium mariannae* Grout. The type material of *P. mariannae* was compared with that of *P. squamatum* from Japan; the plants are similar in all important respects.

Although the type of *I. cuspidifolium*, another Japanese species, was not examined, Iwatsuki (1963), who did see the type, reports that *P. squamatum* is conspecific with it.

Taxiphyllum cuspidifolium, like *T. alternans* Card., has been misidentified as various species of *Plagiothecium*, and both species are probably not so rare as present records indicate. Additional records may eventually be found by re-examining specimens identified as *Plagiothecium*, especially those from the southern states, since *Plagiothecium* has a northern distribution.

Taxiphyllum deplanatum (Sull.) Fleisch., Musci Fl. Buitenzorg 4: 1435. 1922.

Hypnum deplanatum Bruch et Schimp. *ex* Sull. *in* Gray, Man. Bot. N. U. States 670. 1848. Type: "In umbrosioribus ad saxa, terram arborumque truncos, a Canada usque ad Ludoviciam, sat frequens, sed rarissime fructificans: Sullivant," Sullivant, Musci Allegh. 50. (Lectotype NY! US!)

Hypnum deplanatum Schimp. *ex* Sull., Musci Allegh. 50. 1846. (*nom. nud.*)

Stereodon deplanatus (Sull.) Mitt., J. Linn. Soc. Bot. Suppl. 1: 105. 1859.

Isopterygium deplanatum (Sull.) Mitt., J. Linn. Soc. Bot. 12: 498. 1869.

Plagiothecium deplanatum (Sull.) Spruce, J. Bot. 18: 289. 1880.

Rhynchostegium deplanatum (Sull.) Schimp. *ex* Rau et Herv., Cat. N. Amer. Musci 42. 1880.

Plagiothecium deplanatum f. *ovatum* Grout, Moss Fl. N. Amer. 3(3): 161. 1932. Type: "Arizona: Pima Co., Santa Catalina Mts., Mt. Lemmon, Upper Sabino Canyon, alt. 9,000 ft., Oct. 24, 1924," Bartram, Mosses S. Arizona 161 (as *Isopterygium deplanatum*). (Isotype CAN! DUKE! NY! US! WTU!)

Plants glossy, in thin to dense mats, light green to golden green, brownish green with age; stems to 4 cm long, 1–3 mm wide. Stems usually branched, rarely simple, radiculose ventrally. Leaves appressed-imbricate when wet or dry, not plicate, strongly complanate, appearing distichous but in more than two rows, symmetric to somewhat unsymmetric, 0.9–2.0 mm long, 0.4–0.8 mm wide near leaf middle, 0.2–0.4 mm wide at base, broadly ovate to ovate-lanceolate, rarely oblong-lanceolate or oblong-ovate, acuminate or often abruptly narrowed to an acute or filiform apex; margins plane or narrowly recurved for a short distance at base, serrulate to strongly serrate above leaf middle, serrate to serrulate below; costa short and double, sometimes with one branch reaching leaf middle, rarely lacking; leaf cells smooth; median cells linear-flexuose, 47–135 × 7–12μ, much shorter near apex and base, rhomboidal; alar cells 12–27 × 9–17μ, quadrate or some short-rectangular, in 1–several rows with 3–8 cells in marginal row.

Reported as dioicous. Perigonia not seen; perichaetia small, numerous, the bracts lanceolate to ovate-lanceolate, acuminate. Seta 0.7–1.0 cm long. Capsule yellowish brown to light brown. Urn 0.8–1.5 × 0.3–0.5 mm.

Habitat. In shaded areas at low or high elevations (up to 9,000 ft.) on siliceous or calcareous soil and rock, often on bases of trees, and on rotten logs.

DISTRIBUTION. Not uncommon, from Quebec to North Carolina and Tennessee, west to Saskatchewan, Minnesota, Missouri, Arkansas, Louisiana, New Mexico, and Arizona; more common in the northern part of its range. Endemic to North America (Map fig. 8).

Illustrations: Plate XXI.

Chromosome number: Not reported.

Selected Specimens Examined

EXSICCATI. Austin, Musci Appal. 344 as *Rhynchostegium deplanatum* (CAN, DUKE, NY, US); Bartram, Mosses Southern Ariz. 161 as *Isopterygium deplanatum* (CAN, DUKE, NY, US, WTU); Grout, N. Amer. Musci Pl. 174 as *Plagiothecium deplanatum* (DUKE, NY, TENN, US, WTU); Macoun, Can. Musci 300 as *Hypnum deplanatum* (CAN, NY, US); Ren. et Card., Musci Americae Septentrionalis as *P. deplanatum* (CAN, NY); Sull., Musci Allegh. 50 as *Hypnum deplanatum* (NY, US); Sull. et Lesq., Musci Bor. Amer. (Ed. 1) 296 as *H. deplanatum* (NY, WTU), (Ed. 2) 438 as *H. deplanatum* (NY).

CANADA. *Manitoba*: Sprague River, N. of Sprague, *Mueller-Dombois 118-4* (CAN). *Ontario*: Ottawa, *Macoun*, Sept. 26, 1889 (DUKE, US, WTU). *Quebec*: Hull, Beaver Meadow, *Macoun*, April 22, 1899 (CAN, NY, US). *Saskatchewan*: Red Deer River, *Macoun*, July 22, 1881 (CAN).

U.S.A. *Alabama*: Bibb Co., near Pratt's Ferry, *Harper 34* (NY, US). *Arizona*: County unknown, near Bear Point Trail, *Deaver 137* (CAN). *Arkansas*: Washington Co., Boston Mountains, Howard's Bluff, E. of Springdale, *Anderson 12230, 12259* (CAN, DUKE, UBC). *Connecticut*: New Haven Co., Mt. Carmel, *Allen*, March 24, 1877 (NY). *District of Columbia*: Rock Creek, *Holzinger*, June 1891 (US). *Illinois*: Tazewell Co., near East Peoria, Spring Mill Bog, *Chase 10126* (CAN, FSU, US). *Indiana*: Warren Co., ca. 13 mi. SW. of Lafayette, Little Pine Creek Gorge, near High Bridge, *Ireland 5397* (CAN, US). *Iowa*: Winneshiek Co., 2 mi. SE. of Bluffton, *Conard 7-109* (CAN). *Louisiana*: Lafayette Parish, ca. 5 mi. S. of Lafayette, Vermilion Bayou, *Reese and Lemon 6345* (SMS). *Maryland*: Anne Arundel Co., Patuxent River, crossing of Annapolis and Washington Road, *Leonard and Killip 912b* (US). *Michigan*: Washtenaw Co., Ann Arbor, Cascade Glen, *Wilbur*, May 2, 1950 (DUKE). *Minnesota* Clearwater Co., Itasca State Park, road to Bear Point, *Rosendahl 7095* (DUKE). *Missouri*: Douglas Co., ca. 9 mi. SE. of Ava, Sweden Hollow, *Ireland 5461* (CAN, US). *Nebraska*: Sarpy Co., along Elkhorn River, *Bohlen 175* (DUKE). *New Hampshire*: *Grout*, July 15, 1903, locality unknown (NY). *New Jersey*: Bergen Co., Closter, *Austin* in 1866 (NY). *New Mexico*: San Miguel Co., Las Vegas, Hallnos Canyon, *Studhalter S1155* (DUKE). *New York*: Onondaga Co., Jamesville, *Britton*, July 4, 1902 (NY). *North Carolina*: Macon Co., SE. of Rainbow Springs, White Oak Bottoms, *Anderson 13009* (DUKE). *Ohio*: Champaign Co., ½ mi. SE. of Thackery, *E.C. and G.M. Leonard 6041* (US). *Pennsylvania*: McKean Co., near Bradford, *Burnett*, June 15, 1898 (DUKE, NY). *Tennessee*: Monroe Co., Sycamore Creek, *Sharp 54161* (DUKE,

FSU, MICH, SMS, TENN, WTU). *Vermont*: Chittenden Co., Burlington, E. of High Bridge, *Grout*, July 29, 1896 (DUKE, NY). *Virginia*: Page Co., Shenandoah National Park, Jeremys Run Trail, *Ireland 3719, 3735* (US). *West Virginia*: Harrison Co., Fairmont, *Boutlou*, Aug. 27, 1908 (DUKE, NY). *Wisconsin*: Clark Co., near Wolf River, *Culberson 1147* (DUKE).

Taxiphyllum deplanatum has often been misidentified as *T. taxirameum*. Much of the taxonomic confusion has probably resulted from Sullivant's illustrations, which were also used by Grout (1910). The illustrations of *T. taxirameum* (Sullivant 1874, Tab. 70 as *Rhynchostegium geophilum*) were drawn from a plant with short-acuminate leaves, while the illustrations in the plate of *T. deplanatum* (Sullivant 1864, Tab. 108 as *Hypnum deplanatum*) are not typical of that species but, instead, appear to have been drawn from a long-acuminate-leaved plant of *T. taxirameum*. The alar leaf cells in both plates are essentially the same and are typical of *T. taxirameum*, which has poorly differentiated alar cells, with only a few rectangular cells on the margin. This is in contrast to *T. deplanatum*, which has a small area of mostly quadrate or sometimes short-rectangular alar cells, with 3–8 cells in the marginal row.

In addition to the difference in the alar cells, there are a few less reliable characters that can be used to distinguish the two species. *Taxiphyllum deplanatum* commonly has branched stems, light green (sometimes brown with age), erect, appressed-imbricate, broad, smooth leaves with abruptly narrowed apices, leaf margins plane or rarely recurved at base, smooth leaf cells, and a costa usually present. In comparison, *T. taxirameum* usually has simple stems, dark green, wide-spreading to squarrose, distant, narrow, sometimes plicate leaves with gradually narrowed apices, leaf margins commonly recurved nearly to apex, leaf cells sometimes dorsally papillose by projecting cell ends, and the leaves often ecostate.

The distribution and ecology further distinguish the two taxa. *Taxiphyllum deplanatum* is endemic to North America; it is more northern in distribution and rarely occurs in the southern United States. In the northern part of its range, it often grows on bases of trees and on rotten logs, while further south it prefers siliceous or calcareous soil and rock. On the other hand, *T. taxirameum* is a species of tropical affinities, extending into South America; it occurs in the southern United States and only rarely reaches as far north as New York, Pennsylvania, Ohio, Indiana, Illinois, Iowa, and Kansas. It has never been found growing on trees or rotten wood, but always prefers siliceous or calcareous soil and rock. In the central United States, especially in the Ozark Mountains, the two species often grow in proximity.

An Asian species, *T. aomoriense* (Besch.) Iwats., which also grows on bases of trees and on rotting logs, is morphologically close to *T. deplanatum*. This species differs, however, in its leaf apices, which are curved toward the substratum as in *Brotherella recurvans* (Michx.) Fleisch.

The form *ovatum* Grout, which was described from Arizona plants with abruptly acuminate leaves and short cells at the leaf apex, is not worthy of recognition. The leaf apex and apical cells vary so much, even on the same plant, that delimitation of a taxon based on these characters is unwarranted.

Taxiphyllum alternans (Card.) Iwats., J. Hattori Bot. Lab. 26: 67. 1963.

Isopterygium alternans Card., Beih. Bot. Centralbl. 17: 37. 1904. Type: "Syou-Ouen (no. 116, ster.)," collected in Korea by U. Faurie, June 1901. (Holotype PC!).

Isopterygium alternans var. *puteanum* Card., Bull. Soc. Bot. Genève 4 (sér. 2): 386. 1912. Type: "Corée: environs de Seoul, dans un puits (n. 315)," collected in Korea by U. Faurie.

Plagiothecium azumense Yas., Bot. Mag. Tokyo 30: 89. 1916. Type: "Berg Azuma, Prov. Iwashiro, Japan; 13. Juni 1913 (Y. Hattori). Kaigaya-mura, Seta-gun, Prov. Kōtsuke, Japan; 10. März 1910 (K. Tsunoda)." (Syntypes, K. Tsunoda, no. 378 seen. TNS!)

Plagiothecium turgescens Broth., Övers. Finska Vet.-Soc. Förhandl. 62: 46. 1921. Type: "Hondo: Prov. Ise; Tajiri (E. Uematsu 945)," collected in Japan, Dec. 31, 1909. (Holotype H!)

Plagiothecium brevicuspis Broth. *in* Handel-Mazzetti, Symb. Sinic. 4: 116. 1929. ("*es*") Type: "W-Y.: An Kanal rändern (kalkhaltiger Schlamm) am See bei Dali (Talifu), 2070 m. 27. × . 1915 (8557)," collected in Yunnan, China, by H. Handel-Mazzetti and distributed in Verdoorn, Musci Selecti et Critici 292. (Isotype US! WTU!)

Plagiothecium calyptothecioides Dix. et Sak., Bot. Mag. Tokyo 51: 14. 1937. Type: "Kiushiu: Prov. Higo, Oono-Dorf (leg. H. Kaneda in Herb. K. Sakurai Nr. 7548 Typus, 26 Nov. 1935)," Japan. (Holotype MAK!)

Plants glossy, in thin, light green to yellowish green or yellowish brown mats, stems to 6 cm long, 3–5 mm wide. Stems usually simple, naked, or sometimes radiculose ventrally. Leaves distant, becoming close and loosely imbricate at stem apices, spreading wet or dry, complanate, not plicate, sometimes somewhat contorted, symmetric or asymmetric, 1.5–3.5 mm long, 0.8–1.6 mm wide near leaf middle, 0.4–0.6 mm wide at base, ovate to broadly ovate-lanceolate, acuminate to filiform-acuminate, frequently twisted at apex; margins plane or rarely narrowly recurved for a short distance, serrulate to serrate above leaf middle, serrulate to entire below; costa short and double, one branch often extending ⅓–½ length of leaf, rarely lacking; leaf cells smooth; median cells linear-flexuose, 84–156 × 9–12μ, shorter and rhomboidal near apex and base; alar cells 14–43 × 14–20μ, quadrate to long-rectangular, in 1–3 rows, seldom more, with 2–5 cells in marginal row.

Reported as dioicous. Perigonia not seen; perichaetia large, numerous, the bracts lanceolate to ovate-lanceolate, acuminate. Sporophytes unknown.

Habitat. At low elevations on soil beside streams or on humus in bogs and swampy areas.

Distribution. Rare, known from Maryland, Louisiana, and Florida; reported from Asia (Map fig. 8).

Illustrations: Plate XXII.

Chromosome number: Not reported.

Specimens Examined

U.S.A. *Florida*: Gulf Co., Magnolia, *J. D. Smith*, Feb. 1877 (FSU, US); Liberty Co., Torreya State Park, ca. 4 mi. NW. of Rock Bluff, *Pursell 678* (FSU); Liberty Co., Apalachicola River, W. of Bristol, *Pursell 300MF60* (CAN); Liberty Co., Torreya State Park, below Gregory House, *Reese 1059* (FSU, SMS, TENN); Wakulla Co., Newport, *Schornherst 327* (FSU), *756* (MICH). *Louisiana*: Vermilion Parish, ca. 4 mi. S. of Bancker, *Reese 9433* (CAN, LAF). *Maryland*: Montgomery Co., south bank of canal opposite Plummers Island, *Leonard 17487* (US).

It is only recently that *T. alternans* has been recognized in North America, although it was collected by J. D. Smith in Florida in 1877 (as *Rhynchostegium deplanatum* (Sull.) Schimp. *ex* Rau et Herv.) and by E. C. Leonard in Maryland in 1935 (as *Plagiothecium denticulatum* (Hedw.) B.S.G.). The Maryland specimen was the first to come to my attention because of its large size and distinct alar cells, which did not fit any known North American species. Because of the Asiatic affinities of the genus *Taxiphyllum*, the specimen was eventually sent to Dr. Iwatsuki in Japan, who recognized it as the Asian species, *T. alternans*.

Six of the eight known North American collections of *T. alternans* have been made in Florida, although Breen (1963) did not report it for the state. However, *Plagiothecium sylvaticum* (Brid.) B.S.G., which she reports for Liberty and Walton counties, is probably *T. alternans*. The presence of the foliose pseudoparaphyllia in her illustrations of *P. sylvaticum* indicates that the moss is a *Taxiphyllum*, and not a *Plagiothecium*, which lacks pseudoparaphyllia. In addition to the pseudoparaphyllia, *Taxiphyllum* species are easily distinguished from *Plagiothecium* by the nondecurrent leaves and small, thick-walled cortical stem cells.

Taxiphyllum alternans has also been confused with the other three North American species of *Taxiphyllum*. It is especially easy to confuse it with *T. cuspidifolium*, its nearest relative. The characters used in the key best distinguish *T. alternans* from the other species in the genus.

The habitat of *T. alternans* differs from the other species of *Taxiphyllum*. It grows beside streams or in bogs or swamps on noncalcareous soil, logs, roots, and humus. The other species prefer drier habitats, often growing on calcareous soil on rock, sometimes on bases of trees, exposed roots, and rotten wood.

Taxiphyllum taxirameum (Mitt.) Fleisch., Musci Fl. Buitenzorg 4: 1435. 1922.

Stereodon taxirameus Mitt., J. Linn. Soc. Bot. Suppl. 1: 105. 1859. Type: "In Himalayae reg. temp., Simla et Kumaon, T. Thomson! (No. 1008, 1023b). In Nepal, J. D. Hooker! In mont. Khasian, reg. temp., J. D. Hooker et T. Thomson! In Assam superiore, Griffith! In Ceylon, Gardner!" (Lectotype NY! Iwatsuki selected No. 1023, which was on the label, rather than 1023b. Paratype NY! Ceylon, Gardner)

Isopterygium planissimum Mitt., J. Linn. Soc. Bot. 12: 498. 1869. Type: "Ins. Jamaica, Wilson, 675. Andes Quitenses, in ripis fl. Bombonasa (1300 ped.), Spruce, n. 1061." (Syntypes, Wilson specimen seen. NY!)

Rhynchostegium geophilum Aust., Musci Appal. 345. 1870. Type: "On clayey, shaded ground, New Jersey, Austin; Pennsylvania, James; New York, Peck." (Isotype NY! US!)

Isopterygium geophilum (Aust.) Jaeg. et Sauerb., Ber. St. Gall. Naturw. Ges. 1876–77: 437. 1878.

Isopterygium taxirameum (Mitt.) Jaeg. et Sauerb., Ber. St. Gall. Naturw. Ges. 1876–77. 439. 1878.

Hypnum geophilum (Aust.) Lesq. et James, Man. Mosses N. Amer. 358. 1884.

Isopterygium elegantifrons C. Müll., Hedwigia 37: 251. 1898. Type: "St. Domingo, ad arbores montis Isabel de la torre, 400 m alt., 7. VII. 1887: v. Eggers in Hb. Krug et Urban; ad saxa humida et ad arbores juxta flumen Rio Mameyes, 200 m alt., Junio 1887, sterile."

Isopterygium cavernicola Card., Rev. Bryol. 37: 56. 1910. Type: "État de Morelos: près de Cuernavaca, grottes humides, 1908 (no. 15179)," Pringle, Plantae Mexicanae 15179. (Isotype NY!)

Plagiothecium geophilum (Aust.) Grout, Mosses Hand-Lens Microscope 370. 1910.

Taxiphyllum geophilum (Aust.) Fleisch., Musci Fl. Buitenzorg 4: 1435. 1922.

Taxiphyllum planissimum (Mitt.) Broth. *in* Engl. et Prantl, Natür. Pflanzenfam. Ed. 2, 11: 463. 1925.

Taxiphyllum cavernicola (Card.) Thér., Rev. Bryol. et Lichénol. 5: 109. 1932.

Plagiothecium planissimum (Mitt.) Bartr., The Bryologist 49(4): 122. 1946.

Plants glossy, sometimes older ones dull, in thin to dense, dark green to yellowish green mats, stems to 6 cm long, 2–4 mm wide. Stems usually simple or sometimes sparingly branched, rarely radiculose ventrally. Leaves usually stiff, distant, rarely somewhat imbricate, wide-spreading to squarrose when wet or dry, complanate or sometimes concave, in more than two rows but often appearing distichous, smooth or sometimes plicate, symmetric or nearly so, 1.0–2.5 mm long, 0.3–0.6 mm wide near leaf middle, rarely some plants with an occasional leaf 1 mm wide, 0.2–0.4 mm wide at base, ovate-lanceolate or oblong-lanceolate, rarely narrowly ovate, acuminate or abruptly narrowed to an acute or rarely subobtuse apex; margins often narrowly recurved almost to apex, sometimes plane, serrulate to serrate throughout; costa often lacking or short and double with one branch reaching ⅓ length of leaf; leaf cells smooth or often papillose dorsally by projecting cell ends; median cells linear-flexuose, 70–125 × 3–7μ, becoming rhomboidal near apex and sometimes near base; alar cells 37–63 × 5–9μ, usually long to short-rectangular or rarely quadrate, in 1–3 rows with 1–5 cells, rarely more, in marginal row.

Perigonia small, rarely present, the bracts ovate, acute; perichaetia small, numerous, the bracts lanceolate to ovate-lanceolate, acuminate. Seta 0.7–1.2 cm long. Capsule reddish brown. Urn 1.0–1.5 × 0.3–0.5 mm.

HABITAT. In shaded areas at low elevations on siliceous or calcareous soil and rock.

DISTRIBUTION. Not uncommon, from New York to Florida, west to Iowa, Kansas, Oklahoma, Texas, New Mexico, and Arizona; more common in the southern part of its range; reported from Central and South America, West Indies, and Asia (Map fig. 8).

Illustrations: Plate XXIII.

Chromosome number: n = 8.

Selected Specimens Examined

EXSICCATI. Austin, Musci Appal. 345 as *Rhynchostegium geophilum* (CAN, DUKE, NY, US); Grout, N. Amer. Musci Pl. 499 as *Plagiothecium deplanatum* (DUKE, NY, TENN, US, WTU), 369 as *P. geophilum* (CAN, DUKE, NY, TENN, US, WTU), 369a as *P. geophilum* (DUKE, NY, TENN, US, WTU); Sull. et Lesq., Musci Bor. Amer. (Ed. 2) 437 as *Hypnum depressum* (NY).

U.S.A. *Arizona*: Santa Cruz Co., Patagonia Mountains, Sycamore Canyon, *Haring 11498* (CAN). *Arkansas*: Stone Co., Ozark Mountains, Blanchard Springs, N. of Allison, *Anderson 11696* (CAN, FSU). *Delaware*: Kent Co., S. of Smyra, *Conard*, Oct. 17, 1949 (LAWT). *District of Columbia*: Rock Creek Park, *Holzinger*, May 24, 1891 (US). *Florida*: Jackson Co., near Blue Springs, ca. 5 mi. NE. of Marianna, *Redfearn 2298* (FSU, SMS, TRTC, US, WTU). *Georgia*: Decatur Co., Forest Falls, *Harper 1190b* (NY, US). *Illinois*: Clark Co., Rocky Branch, *Woods 38* (TENN). *Indiana*: Warren Co., ca. 13 mi. SW. of Lafayette, Little Pine Creek Gorge, near High Bridge, *Ireland 5397a* (CAN, US). *Iowa*: Marion Co., Red Rock, *Conard*, Aug. 26, 1936 (NY). *Kansas*: Woodson Co., Woodson County State Park, S. of Batesville, *Ireland 9767* (CAN). *Kentucky*: Lewis Co., 1 mi. E. of Vanceburg, *Wharton 5344* (CAN, NY). *Louisiana*: Evangeline Parish, Chicot State Park, *Reese 2512* (CAN, US). *Maryland*: Montgomery Co., Great Falls, *Killip 7450* (US). *Missouri*: Barton Co., ca. 15 mi. NW. of Lamar, *Redfearn 6323* (SMS); Cedar Co., 4 mi. NW. of Jerico Springs, *Ireland 3328* (US). *New Jersey*: Hunterdon Co., Flemington, *Best*, Dec. 17, 1890 (NY). *New Mexico*: Dona Ana Co., Organ Mountains, Van Patten's Camp, *Wooton 3752* (DUKE, NY). *New York*: Albany Co., Albany, *Peck s. n.*, no date (NY). *North Carolina*: Polk Co., 3 mi. NW. of Tryon, *Anderson 2696* (DUKE). *Ohio*: Montgomery Co., Dayton, *Jewett 2851* (DUKE). *Oklahoma*: Tulsa Co., SW. of Tulsa, *Whitehouse 26257* (CAN, US). *Pennsylvania*: Philadelphia Co., Philadelphia, near Schuylkill River, *James*, Oct. 1864 (CAN, US). *South Carolina*: Pickens Co., between Rosman and Pickens, *D. S. and H. B. Correll 7915* (DUKE). *Tennessee*: Polk Co., Ocoee River, *Sharp 6310* (TENN). *Texas*: Johnson Co., SW. of Cleburne, near Brazon River, *Whitehouse 26869* (CAN). *Virginia*: Albemarle Co., Shenandoah National Park, Jones Run Falls Trail, *Ireland 2350* (CAN, US). *West Virginia*: Preston Co., Cheat Mountains, Cave Big Beaver Hole, *Millspaugh 845* (NY).

An examination of the types of the Asiatic species *Stereodon taxirameus* Mitt. and of the North American species *Rhynchostegium geophilum* Aust. showed no significant differences that could be used to distinguish the two. Many leaves of the *Stereodon* type were plicate, but leaf plications occasionally occur in many specimens in North America and Asia, particularly those growing in xerophytic habitats. The name *T. taxirameum* has priority and must therefore replace the name *T. geophilum*, which has been used for the North American material.

The types of two tropical species, *I. planissimum* Mitt. and *I. cavernicola* Card., were also examined and were found to be conspecific with *T. taxirameum*. Previously they had been separated from the more northern occurring *T. taxirameum*, mainly on the basis of distribution.

Taxiphyllum taxirameum and the other species of the genus *Taxiphyllum* are very rarely, if ever, found with sporophytes. The dioicous condition probably accounts for the paucity of fruiting plants. Archegonial plants are not uncommon, but antheridial ones are rare, and in some North American species they have never been found. While many dioicous mosses rely on various types of asexual reproductive bodies for propagation, none of the *Taxiphyllum* species examined was observed to possess them. Although propagula were reported for *T. taxirameum* (as *I. geophilum*) by Jennings (1951), the description and illustrations were based on a plant collected by C. M. Boardman in Somerset Co., Pennsylvania. An examination of this moss in the herbarium of the Carnegie Institute in Pittsburgh, Pennsylvania, clearly indicates that it is *I. distichaceum*.

Doubtful or Excluded Taxa

Hypnum scitulum Aust., Bull. Torrey Bot. Club 6(6): 44. 1875. Type: "Mixed with *H. sprucei* in Drummond's Musci of British and Arctic America," distributed as No. 190. (Isotype NY!)

Rhynchostegium scitulum (Aust.) Rau et Herv., Cat. N. Amer. Musci 43. 1880.

Although *Hypnum scitulum* has been cited as a synonym of *Plagiothecium latebricolum* B.S.G., an examination of the type shows that this moss belongs to the *Brachytheciaceae*.

Plagiothecium auriculatum Kindb. *in* Mac. et Kindb., Cat. Can. Plants 6: 215. 1892.

This is apparently a *nomen nudum*. A specimen from Kindberg's herbarium in Stockholm, which is named this species with "n. sp." following the name, is *Heterophyllium haldanianum* (Grev.) Kindb.

Plagiothecium bifaricellum Kindb. *in* Mac., Bull. Torrey Bot. Club 17(11): 279. 1890. Type: "Wet places in woods at Comox, Vancouver Island, May 3, 1887," collected by Macoun. (Holotype S–PA!)

This is apparently a species of *Eurhynchium*. The specimen seen from Kindberg's herbarium, and believed to be the type, has a different date on the label (April 30, 1887). Grout annotated the specimen as "A depauperate *Eurhynchium praelongum*."

Plagiothecium brevipungens Kindb. *in* Mac. et Kindb., Cat. Can. Plants 6: 215. 1892. Type: "On stones in McKay's woods, Ottawa, Ont., May 21st, 1885 (Macoun)." (Holotype S–PA!)

Grout (1932), who reported "type seen," stated that this moss was a *Hygrohypnum*, but the holotype from Kindberg's herbarium contained only *Heterophyllium haldanianum* (Grev.) Kindb.

Plagiothecium diversifolium Kindb. *in* Mac., Cat. Can. Plants 7: 300. 1902. (*nom. nud.*)

Plagiothecium membranosum Kindb. *in* Mac. et Kindb., Cat. Can. Plants 6: 215. 1892. Type: "On dead wood in Dow's swamp, near Ottawa, Oct. 17th, 1884; on old logs at Belleville, Ont., June 19th, 1874 (Macoun)." (Syntypes, Belleville specimen seen. S–PA!)

A probable syntype was seen from Kindberg's herbarium with the following information: "Canada: Belleville, J. Macoun n. sp." It is a species of *Hypnum*.

Taxiphyllum andersonii (Bartr.) Crum, The Bryologist 68(2): 219. 1965.

Glossadelphus andersonii Bartr., The Bryologist 54(2): 81. 1951. Type: "South Carolina: Oconee County, moist vertical rock, cool ravine, hemlock-hardwood community, Lower Falls, Whitewater River, about 3 miles northwest of Jocassee, alt. 1500 ft., June 6, 1950, Lewis E. Anderson No. 9237." (Holotype FH!)

This is a small sterile moss, known only from the type locality. It has obtuse, shortly decurrent leaves; leaf cells that are sometimes dorsally papillose by projecting cell ends; small thick-walled cortical stem cells; and it lacks pseudoparaphyllia. Because of the shortly decurrent leaves and the absence of pseudoparaphyllia, it does not belong to the genus *Taxiphyllum*, but it may belong to the genus *Isopterygium*. However, it seems best not to make the combination at this time but to leave the species in the genus *Glossadelphus* for the present. Meanwhile, subsequent collections may help to clarify its position. This view is also shared by Dr. Iwatsuki, who saw the type (pers. comm.).

Excluded from the species known to occur in North America

Plagiothecium platyphyllum Mönk.

This species was reported from Alaska by Persson (1952). Although the specimens upon which the report was based were not seen, this dioicous species seems to be a doubtfully valid segregate of *P. roeseanum* B.S.G., or it may possibly be a tetraploid of *P. denticulatum* (Hedw.) B.S.G. (*see* discussion under *P. denticulatum* in Chromosome Studies). Since *P. platyphyllum* has been defined differently by different authors, it is necessary to see the type to clarify its taxonomic position. Thus far, all attemps to locate it have failed.

Plagiothecium sylvaticum (Brid.) B.S.G.

Drs. L. E. Anderson and S. W. Greene (pers. comm.) were the first to discover that this European species does not occur in North America. Most of the North American plants named *P. sylvaticum* are depauperate *P. roeseanum* B.S.G. (for distinctions, *see* discussion under *P. roeseanum* in Taxonomic Treatment). The following are synonyms of *P. sylvaticum* and are also excluded from North America:

P. sylvaticum var. *orthocladium* (B.S.G.) Schimp.

P. sylvaticum var. *succulentum* (Wils.) Spruce

P. neglectum Mönk.

Synonyms

Campylium

C. fitzgeraldii = *Sharpiella striatella*
C. striatellum = *Sharpiella striatella*

Dolichotheca

D. pilifera = *Plagiothecium piliferum*
D. repens = *Sharpiella seligeri*
D. seligeri = *Sharpiella seligeri*
D. silesiana = *Sharpiella seligeri*
D. striatella = *Sharpiella striatella*
D. striatella var. *chrysophylloides* = *Sharpiella striatella*
D. turfacea = *Sharpiella turfacea*

Hypnum

H. albulum = *Isopterygium tenerum*
H. albulum var. *ursorum* = *Isopterygium tenerum*
H. borrerianum = *Isopterygium elegans*
H. cavifolium = *Plagiothecium denticulatum*
H. chapmannii = *Isopterygium tenerum*
H. chrysophylloides = *Sharpiella striatella*
H. collinum = *Isopterygium elegans*
H. contextum = *Isopterygium pulchellum*
H. denticulatum = *Plagiothecium denticulatum*
H. denticulatum var. *densum* = *Plagiothecium denticulatum*
H. denticulatum var. *donnianum* = *Plagiothecium denticulatum*
H. denticulatum var. *laxum* = *Plagiothecium denticulatum*
H. denticulatum var. *laetum* = *Plagiothecium laetum*
H. denticulatum var. *majus* = *Plagiothecium denticulatum*
H. denticulatum var. *obtusifolium* = *Plagiothecium denticulatum*
H. denticulatum var. *piliferum* = *Plagiothecium piliferum*
H. deplanatum = *Taxiphyllum deplanatum*
H. donnianum = *Plagiothecium denticulatum*
H. elegans = *Isopterygium elegans*
H. elegans var. *collinum* = *Isopterygium elegans*
H. elegans var. *terrestre* = *Isopterygium elegans*
H. fitzgeraldii = *Sharpiella striatella*
H. fulvum = *Isopterygium tenerum*
H. geminum = *Isopterygium pulchellum*
H. geophilum = *Taxiphyllum taxirameum*
H. latebricolum = *Plagiothecium latebricolum*

H. micans = *Isopterygium tenerum*
H. muehlenbeckii = *Sharpiella striatella*
H. muellerianum = *Isopterygium muellerianum*
H. nitidulum = *Isopterygium pulchellum*
H. nitidulum var. *suberectum* = *Isopterygium pulchellum*
H. obtusifolium = *Plagiothecium denticulatum*
H. orthocarpon = *Plagiothecium piliferum*
H. passaicense = *Isopterygium pulchellum*
H. planifolium = *Isopterygium elegans*
H. pseudo-silesiacum = *Sharpiella striatella*
H. pulchellum = *Isopterygium pulchellum*
H. pulchellum var. *nitidulum* = *Isopterygium pulchellum*
H. roeseanum = *Plagiothecium roeseanum*
H. rutilans = *Isopterygium pulchellum*
H. seligeri = *Sharpiella seligeri*
H. serpens var. *repens* = *Sharpiella seligeri*
H. silesianum = *Sharpiella seligeri*
H. striatellum = *Sharpiella striatella*
H. subfalcatum = *Isopterygium distichaceum*
H. sullivantiae = *Plagiothecium roeseanum*
H. tenerum = *Isopterygium tenerum*
H. trichophorum = *Plagiothecium piliferum*
H. trichophorum var. *brevipilum* = *Plagiothecium piliferum*
H. turfaceum = *Sharpiella turfacea*
H. undulatum = *Plagiothecium undulatum*

Isopterygium

I. albulum = *Isopterygium tenerum*
I. alternans = *Taxiphyllum alternans*
I. alternans var. *puteanum* = *Taxiphyllum alternans*
I. borrerianum = *Isopterygium elegans*
I. borrerianum var. *gracilens* = *Isopterygium elegans*
I. borrerianum var. *terrestre* = *Isopterygium elegans*
I. cavernicola = *Taxiphyllum taxirameum*
I. cuspidifolium = *Taxiphyllum cuspidifolium*
I. deplanatum = *Taxiphyllum deplanatum*
I. drummondii = *Isopterygium tenerum*
I. elegans var. *schimperi* = *Isopterygium elegans*
I. elegans var. *terrestre* = *Isopterygium elegans*
I. elegantifrons = *Taxiphyllum taxirameum*
I. fitzgeraldii = *Sharpiella striatella*
I. fulvens = *Isopterygium tenerum*
I. fulvum = *Isopterygium tenerum*
I. fulvum f. *latifolium* = *Isopterygium tenerum*
I. geminum = *Isopterygium pulchellum*
I. geophilum = *Taxiphyllum taxirameum*
I. groutii = *Isopterygium tenerum*
I. latebricolum = *Plagiothecium latebricolum*
I. ludovicianum = *Isopterygium tenerum*

I. micans = *Isopterygium tenerum*
I. micans var. *groutii* = *Isopterygium tenerum*
I. micans var. *latifolium* = *Isopterygium tenerum*
I. micans var. *minus* = *Isopterygium tenerum*
I. nitidulum = *Isopterygium pulchellum*
I. nitidulum ssp. *muellerianum* = *Isopterygium muellerianum*
I. nitidulum var. *pulchellum* = *Isopterygium pulchellum*
I. nitidulum var. *suberectum* = *Isopterygium pulchellum*
I. passaicense = *Isopterygium pulchellum*
I. piliferum = *Plagiothecium piliferum*
I. planissimum = *Taxiphyllum taxirameum*
I. poasense = *Isopterygium distichaceum*
I. pseudo-latebricolum = *Isopterygium pulchellum*
I. pseudo-silesiacum = *Sharpiella striatella*
I. pulchellum var. *nitidulum* = *Isopterygium pulchellum*
I. repens = *Sharpiella seligeri*
I. seligeri = *Sharpiella seligeri*
I. silesianum = *Sharpiella seligeri*
I. striatellum = *Sharpiella striatella*
I. subfalcatum = *Isopterygium distichaceum*
I. sulcatum = *Sharpiella turfacea*
I. taxirameum = *Taxiphyllum taxirameum*
I. turfaceum = *Sharpiella turfacea*

Isothecium

I. elegans = *Isopterygium elegans*
I. tenerum = *Isopterygium tenerum*

Leskea

L. flaccida = *Plagiothecium denticulatum*
L. hamosa = *Plagiothecium laetum*
L. laeta = *Plagiothecium laetum*
L. latebricola = *Plagiothecium latebricolum*
L. nitida = *Isopterygium pulchellum*
L. pilifera = *Plagiothecium piliferum*
L. pulchella = *Isopterygium pulchellum*
L. seligeri = *Sharpiella seligeri*
L. striatella = *Sharpiella striatella*

Neckera

N. pilifera = *Plagiothecium piliferum*

Neckeropsis

N. undulata = *Plagiothecium undulatum*

Plagiotheciella

P. latebricola = *Plagiothecium latebricolum*
P. passaicensis = *Isopterygium pulchellum*
P. piliferum = *Plagiothecium piliferum*

Plagiothecium

P. aciculari-pungens = *Plagiothecium roeseanum*
P. albulum = *Isopterygium tenerum*
P. arnoldii = *Isopterygium pulchellum*
P. attenuatirameum = *Plagiothecium roeseanum*
P. azumense = *Taxiphyllum alternans*
P. borrerianum = *Isopterygium elegans*
P. borrerianum var. *collinum* = *Isopterygium elegans*
P. boscii ssp. *aciculari-pungens* = *Plagiothecium roeseanum*
P. brevicuspis = *Taxiphyllum alternans*
P. calyptothecioides = *Taxiphyllum alternans*
P. chapmannii = *Isopterygium tenerum*
P. curvifolium = *Plagiothecium laetum*
P. decursivifolium = *Plagiothecium laetum*
P. densum = *Plagiothecium denticulatum*
P. denticulatum ssp. *aptychus* = *Plagiothecium laetum*
P. denticulatum var. *aptychus* = *Plagiothecium laetum*
P. denticulatum var. *bullulae* = *Plagiothecium denticulatum*
P. denticulatum var. *crispatulum* = *Plagiothecium denticulatum*
P. denticulatum var. *curvifolium* = *Plagiothecium laetum*
P. denticulatum var. *densum* B.S.G. = *Plagiothecium denticulatum*
P. denticulatum var. *densum* Saut. *ex* Rabenh. = *Isopterygium elegans*
P. denticulatum ssp. *denticulatum* = *Plagiothecium denticulatum*
P. denticulatum ssp. *donnianum* = *Plagiothecium denticulatum*
P. denticulatum var. *donnianum* = *Plagiothecium denticulatum*
P. denticulatum var. *eciliatum* = *Plagiothecium laetum*
P. denticulatum var. *gravetii* = *Plagiothecium laetum*
P. denticulatum var. *hecynicum* = *Plagiothecium laetum*
P. denticulatum ssp. *laetum* = *Plagiothecium laetum*
P. denticulatum var. *laetum* = *Plagiothecium laetum*
P. denticulatum var. *laxum* = *Plagiothecium denticulatum*
P. denticulatum var. *majus* = *Plagiothecium denticulatum*
P. denticulatum var. *microcarpum* = *Plagiothecium laetum*
P. denticulatum var. *myurum* = *Plagiothecium roeseanum*
P. denticulatum var. *obtusifolium* = *Plagiothecium denticulatum*
P. denticulatum var. *propaguliferum* = *Plagiothecium denticulatum*
P. denticulatum f. *propaguliferum* = *Plagiothecium denticulatum*
P. denticulatum var. *pusillum* = *Plagiothecium laetum*
P. denticulatum var. *recurvum* = *Plagiothecium laetum*
P. denticulatum ssp. *ruthei* = *Plagiothecium denticulatum*
P. denticulatum var. *ruthei* = *Plagiothecium denticulatum*
P. denticulatum ssp. *sulcatum* = *Plagiothecium denticulatum*
P. denticulatum var. *tenellum* = *Plagiothecium laetum*
P. denticulatum var. *undulatum* = *Plagiothecium denticulatum*
P. deplanatum = *Taxiphyllum deplanatum*
P. deplanatum f. *ovatum* = *Taxiphyllum deplanatum*
P. donnianum = *Plagiothecium denticulatum*
P. elegans = *Isopterygium elegans*

P. elegans var. *gracilens* = *Isopterygium elegans*
P. elegans var. *gracilis* = *Isopterygium elegans*
P. elegans var. *schimperi* = *Isopterygium elegans*
P. elegans var. *subfalcatum* = *Isopterygium distichaceum*
P. elegans var. *terrestre* = *Isopterygium elegans*
P. fallax = *Plagiothecium roeseanum*
P. fitzgeraldii = *Sharpiella striatella*
P. fulvum = *Isopterygium tenerum*
P. geminum = *Isopterygium pulchellum*
P. geophilum = *Taxiphyllum taxirameum*
P. gravetii = *Plagiothecium laetum*
P. groutii = *Isopterygium tenerum*
P. laetum ssp. *attenuatirameum* = *Plagiothecium roeseanum*
P. laetum var. *densum* = *Plagiothecium denticulatum*
P. laetum var. *neomexicanum* = *Plagiothecium laetum*
P. laetum var. *tenellum* = *Plagiothecium laetum*
P. lucens = *Plagiothecium roeseanum*
P. mariannae = *Taxiphyllum cuspidifolium*
P. micans = *Isopterygium tenerum*
P. micans var. *fulvum* = *Isopterygium tenerum*
P. micans var. *groutii* = *Isopterygium tenerum*
P. micans var. *latifolium* = *Isopterygium tenerum*
P. micans f. *latifolium* = *Isopterygium tenerum*
P. micans var. *minus* = *Isopterygium tenerum*
P. micans var. *submersum* = *Isopterygium tenerum*
P. micans var. *ursorum* = *Isopterygium tenerum*
P. muehlenbeckii = *Sharpiella striatella*
P. muehlenbeckii var. *chrysophylloides* = *Sharpiella striatella*
P. muellerianum = *Isopterygium muellerianum*
P. myurum = *Plagiothecium undulatum*
P. nitidulum = *Isopterygium pulchellum*
P. nitidulum var. *pulchellum* = *Isopterygium pulchellum*
P. nitidulum var. *suberectum* = *Isopterygium pulchellum*
P. obtusifolium = *Plagiothecium denticulatum*
P. passaicense = *Isopterygium pulchellum*
P. piliferum var. *brevipilum* = *Plagiothecium piliferum*
P. piliferum f. *brevipilum* = *Plagiothecium piliferum*
P. planissimum = *Taxiphyllum planissimum*
P. pseudo-latebricolum = *Isopterygium pulchellum*
P. pseudo-silesiacum = *Sharpiella striatella*
P. pulchellum = *Isopterygium pulchellum*
P. pulchellum var. *nitidulum* = *Isopterygium pulchellum*
P. repens = *Sharpiella seligeri*
P. ruthei = *Plagiothecium denticulatum*
P. ruthei var. *propaguliferum* = *Plagiothecium denticulatum*
P. sandbergii = *Plagiothecium denticulatum*
P. schimperi = *Isopterygium elegans*
P. seligeri = *Sharpiella seligeri*
P. silesianum = *Sharpiella seligeri*

P. squamatum = *Taxiphyllum cuspidifolium*
P. striatellum = *Sharpiella striatella*
P. striatellum var. *chrysophylloides* = *Sharpiella striatella*
P. subfalcatum = *Isopterygium distichaceum*
P. sulcatum = *Sharpiella turfacea*
P. sullivantiae = *Plagiothecium roeseanum*
P. sylvaticum var. *cavifolium* = *Plagiothecium roeseanum*
P. sylvaticum var. *myurum* = *Plagiothecium roeseanum*
P. sylvaticum var. *roeseanum* = *Plagiothecium roeseanum*
P. sylvaticum var. *squarrosum* = *Plagiothecium denticulatum*
P. sylvaticum var. *sullivantiae* = *Plagiothecium roeseanum*
P. tenellum = *Plagiothecium laetum*
P. trichophorum = *Plagiothecium piliferum*
P. turfaceum = *Sharpiella turfacea*
P. turgescens = *Taxiphyllum alternans*
P. undulatum var. *myurum* = *Plagiothecium undulatum*
P. undulatum f. *myurum* = *Plagiothecium undulatum*

Rhaphidostegium

R. ludovicianum = *Isopterygium tenerum*
R. micans = *Isopterygium tenerum*
R. micans var. *submersum* = *Isopterygium tenerum*

Rhynchostegium

R. deplanatum = *Taxiphyllum deplanatum*
R. elegans = *Isopterygium elegans*
R. elegans var. *collinum* = *Isopterygium elegans*
R. elegans var. *terrestre* = *Isopterygium elegans*
R. geophilum = *Taxiphyllum taxirameum*
R. micans = *Isopterygium tenerum*
R. micans var. *albulum* = *Isopterygium tenerum*

Stereodon

S. denticulatus = *Plagiothecium denticulatum*
S. deplanatus = *Taxiphyllum deplanatum*
S. distichaceus = *Isopterygium distichaceum*
S. donnianus = *Plagiothecium denticulatum*
S. geminus = *Isopterygium pulchellum*
S. nitidulus = *Isopterygium pulchellum*
S. pulchellus = *Isopterygium pulchellum*
S. taxirameus = *Taxiphyllum taxirameum*
S. turfaceus = *Sharpiella turfacea*
S. undulatus = *Plagiothecium undulatum*

Taxiphyllum

T. cavernicola = *Taxiphyllum taxirameum*
T. geophilum = *Taxiphyllum taxirameum*
T. howellianum = *Isopterygium distichaceum*
T. mariannae = *Taxiphyllum cuspidifolium*
T. planissimum = *Taxiphyllum taxirameum*
T. squamatum = *Taxiphyllum cuspidifolium*

Addenda

Recently, several important type specimens, which were described by S. E. Bridel-Brideri, were located by Dr. Z. Iwatsuki (Hattori Botanical Laboratory, Japan) and obtained on loan from the Botanisches Museum in Berlin (B). An examination of these valuable specimens revealed the following information:

Plagiothecium sylvaticum (Brid.) B.S.G.

A lectotype of *Hypnum sylvaticum* Brid., which was selected by Dr. Iwatsuki, was examined; it bears the label data "Saltus Thuringicus in paluda Teufelscaneis diêtâ." The plants have decurrent leaves with the decurrent region tapering and often being composed of many inflated, spherical cells. The median leaf cells are 17–19μ wide, and many of the plants are autoicous with capsules that are weakly striate. Plants with this combination of characters fit my concept of *P. denticulatum* (Hedw.) B.S.G., which is based on specimens of this taxon in the Hedwig Herbarium at Geneva. Also, many of the other specimens that were seen from the Bridel Herbarium were similar to *P. denticulatum*. Unless a specimen that Bridel has labelled as "Type" turns up and proves to be something different from the other specimens seen in the Bridel Herbarium, I believe it is well advised to consider *P. sylvaticum* a synonym of *P. denticulatum*.

Leskea flaccida Brid. and **Hypnum cavifolium** Brid.

Leskea flaccida and *Hypnum cavifolium* have both been considered synonyms of *Plagiothecium denticulatum* (Hedw.) B.S.G. by bryologists for many years. After studying the holotype of the *Hypnum* and a possible holotype of the *Leskea*, Dr. Iwatsuki noted that the plants are actually similar to *P. roeseanum* B.S.G. Having seen the types of all taxa involved, I concur with this. Since both taxa were validly published by Bridel in 1827, before Bruch, Schimper, and Gümbel described *P. roeseanum* in 1851, *L. flaccida* and *H. cavifolium* have priority. Because *Leskea flaccida* was described on page 308 of *Bryologia Universa*, vol. 2, while *Hypnum cavifolium* (as *H. cavifolius*) was described on page 556, the former name is the valid one. Dr. Iwatsuki will make a new combination in the near future.

Sharpiella striatella (Brid.) Iwats.

A holotype of *Leskea striatella* Brid. was studied, and the North American collections referred to as *S. striatella* are morphologically similar.

Hypnum planifolium Brid.

A holotype of *Hypnum planifolium* was found to be similar to *Ctenidium molluscum* (Hedw.) Mitt. *Hypnum planifolium* was formerly considered a synonym of *Isopterygium elegans* (Brid.) Lindb.

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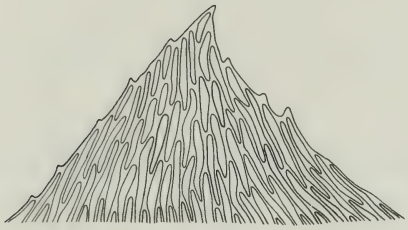
ILLUSTRATIONS

PLATES II TO XXIII

AND

FIGURES 1 TO 8



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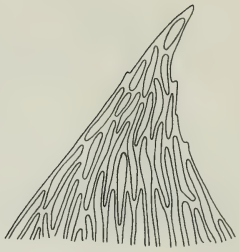

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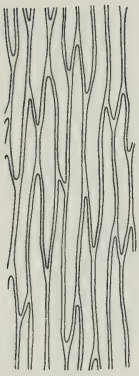

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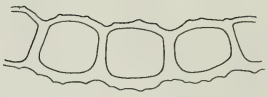

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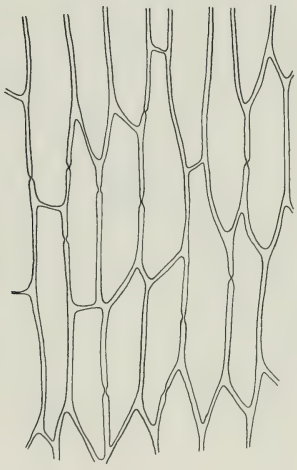

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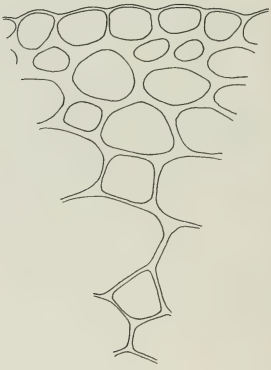

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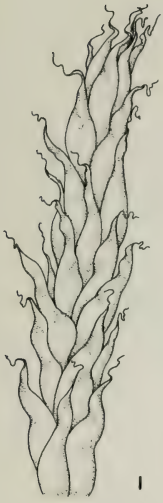

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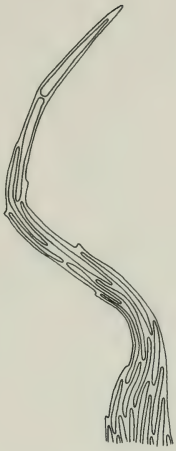

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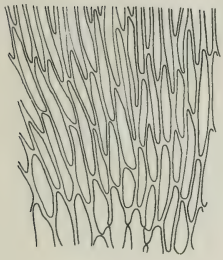

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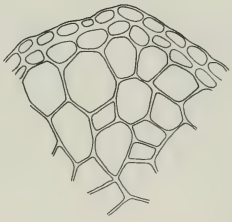

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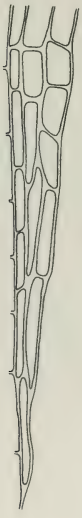

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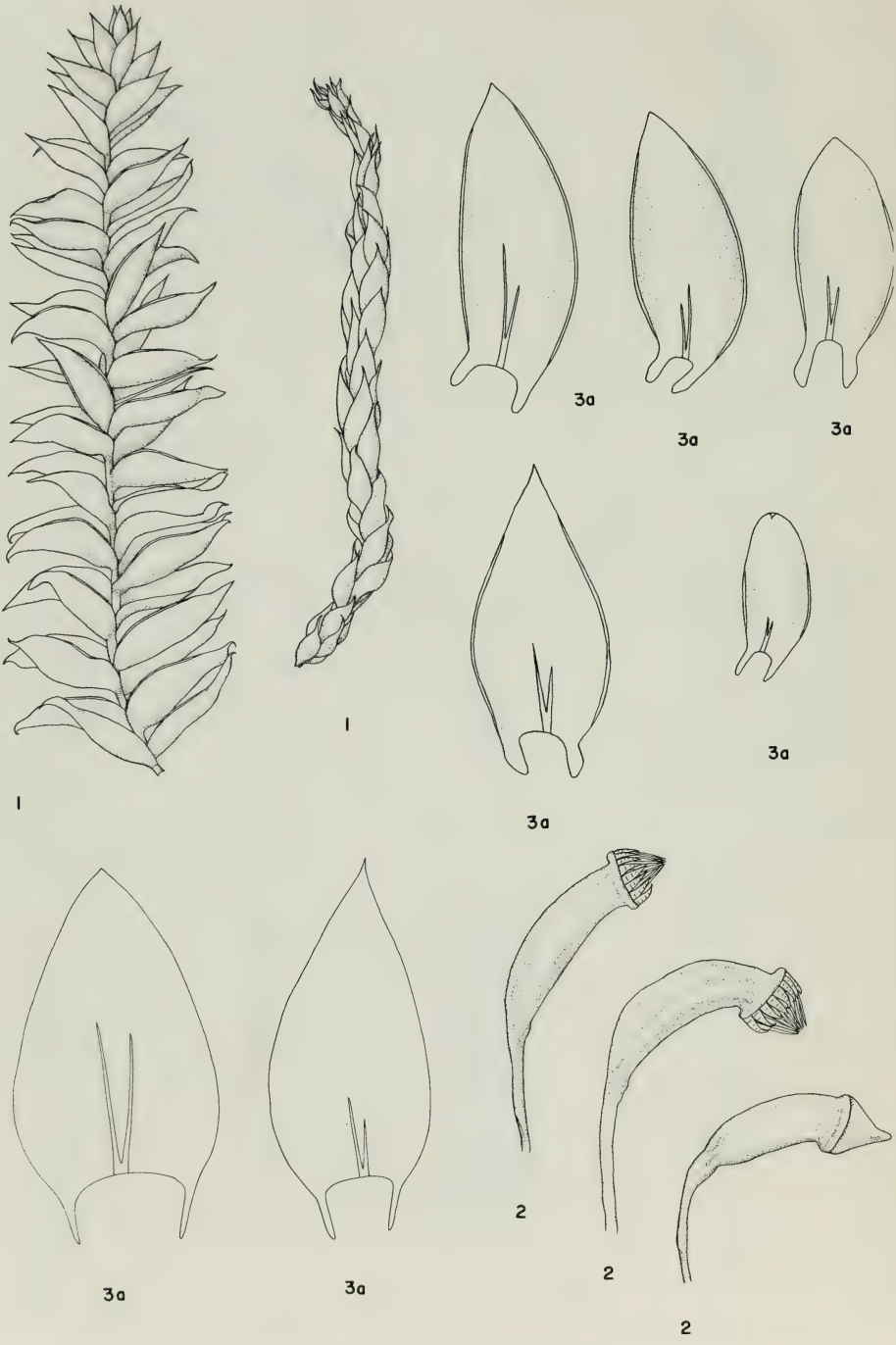

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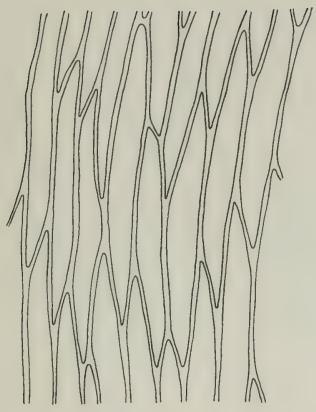

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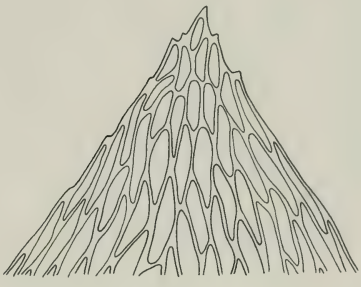

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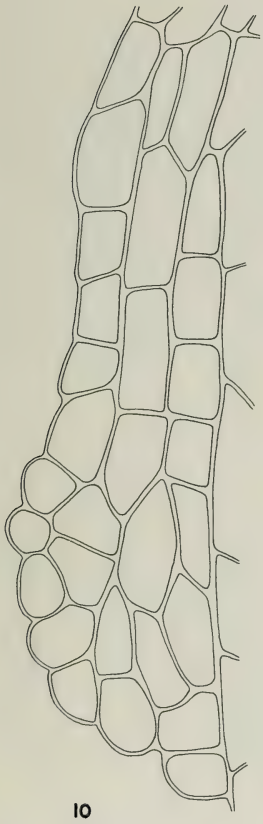

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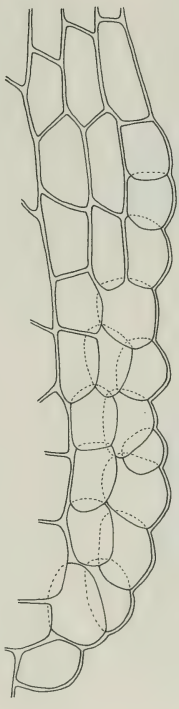

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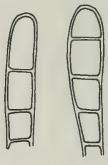

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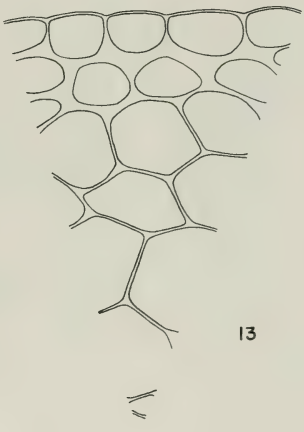

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Plagiothecium denticulatum

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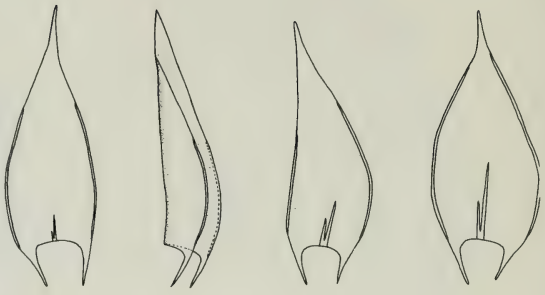

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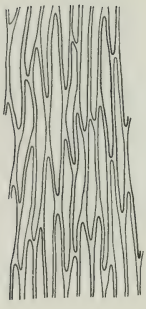

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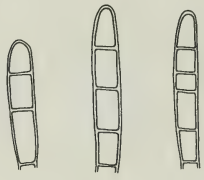

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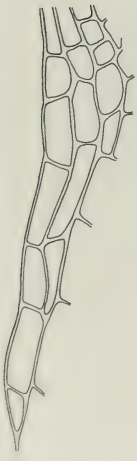

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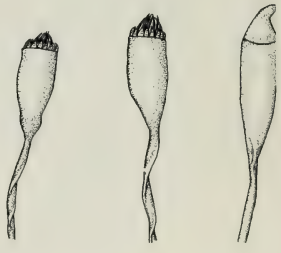

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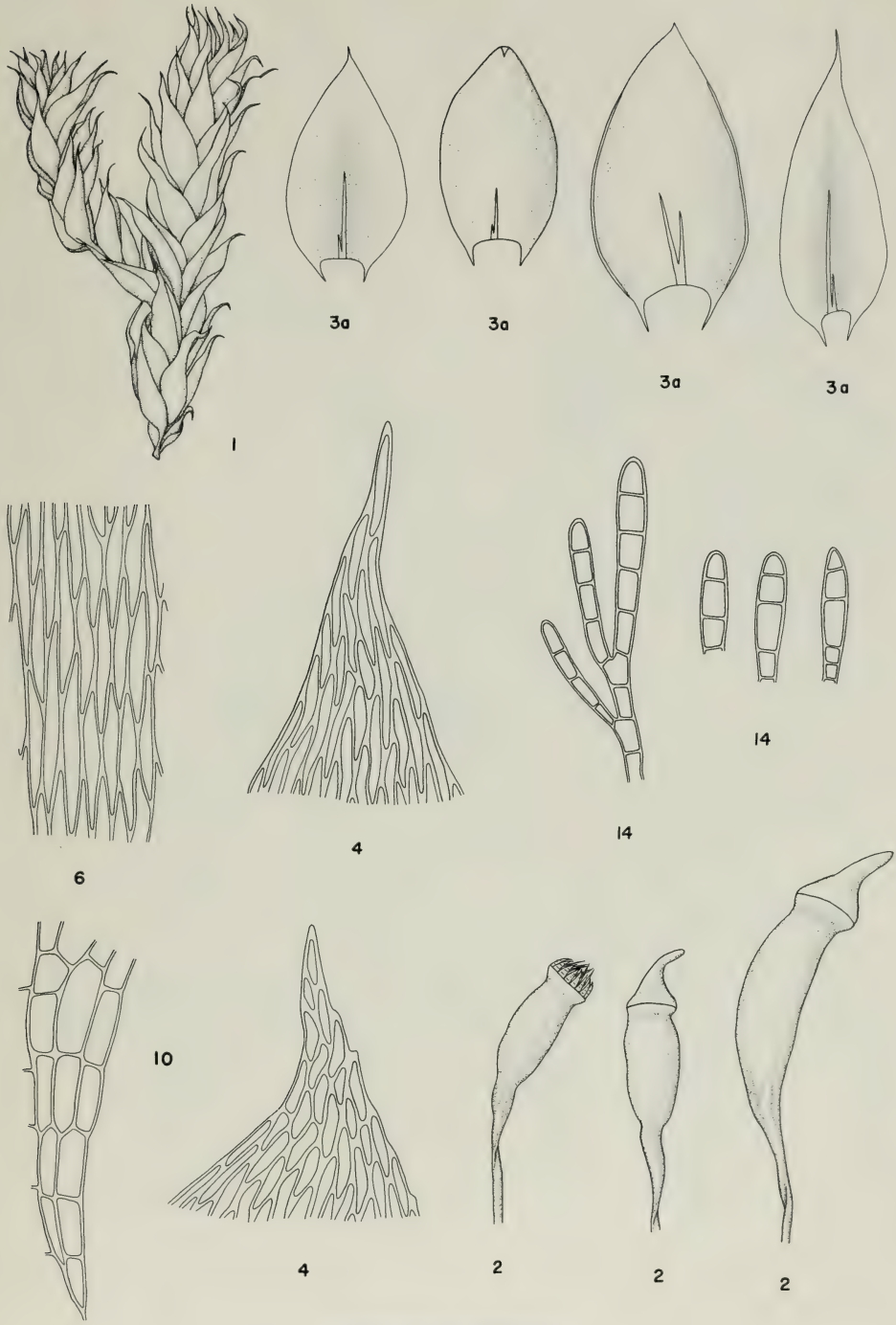

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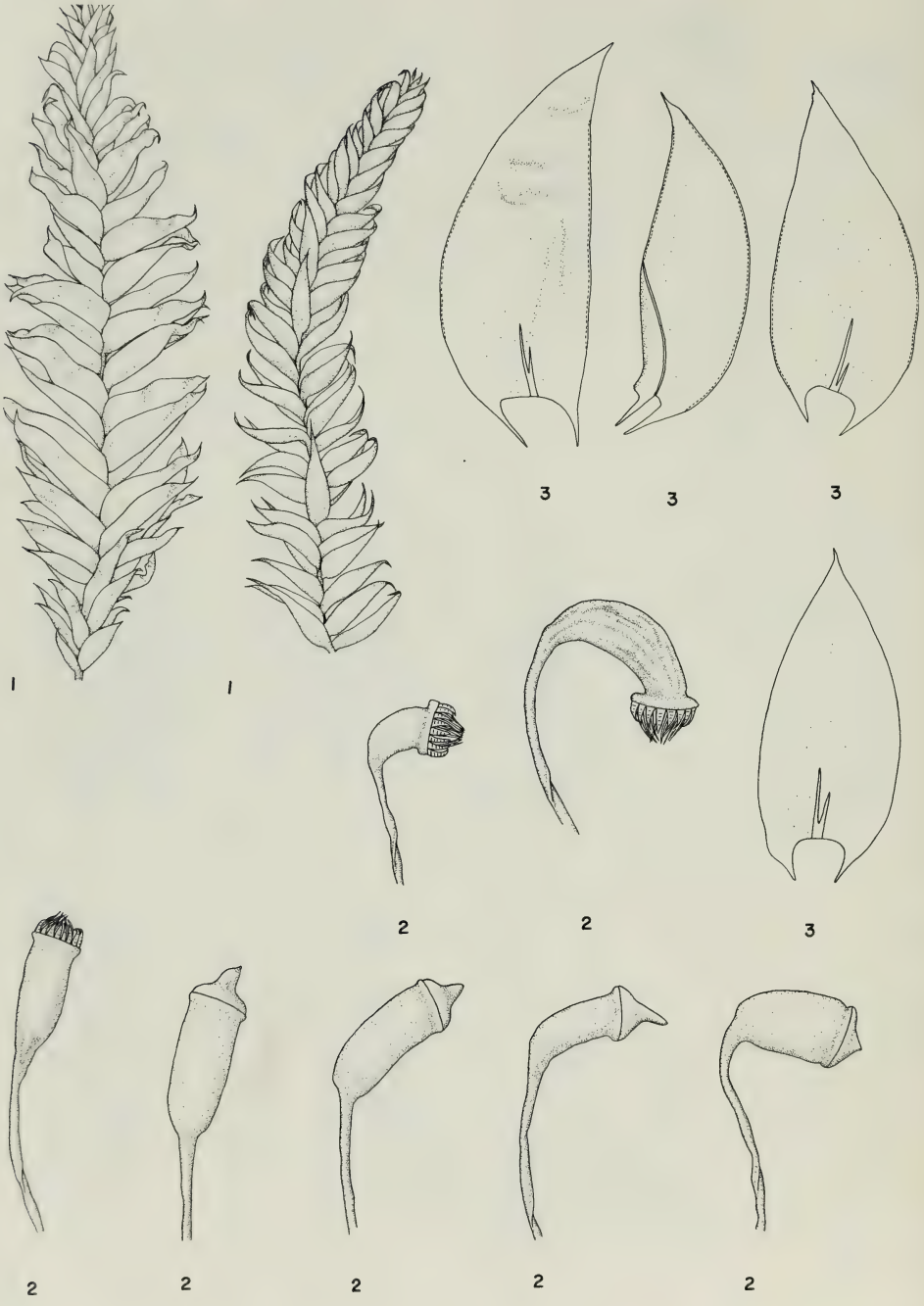

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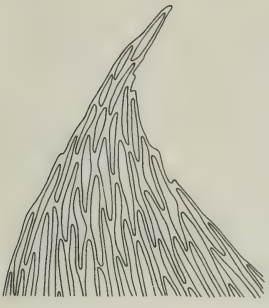

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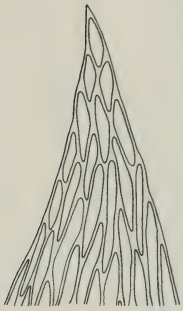

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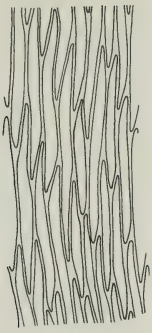

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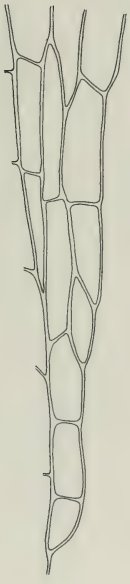

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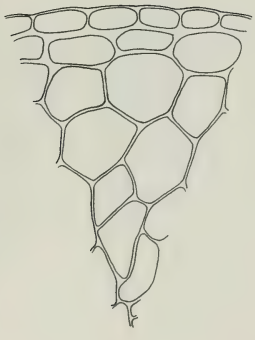

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Plagiothecium laetum

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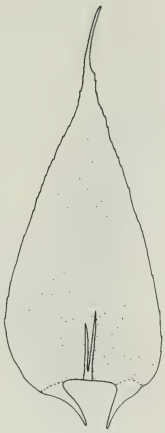

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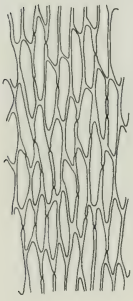

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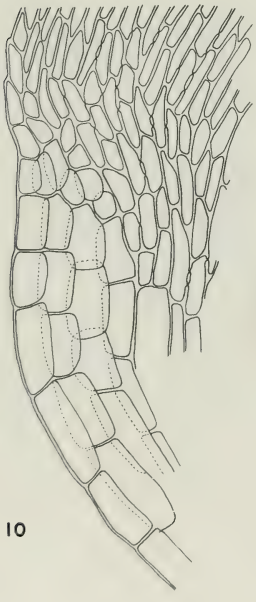

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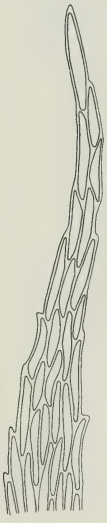

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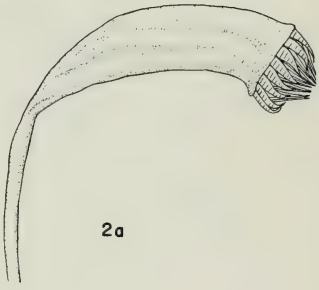

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Sharpiella striatella

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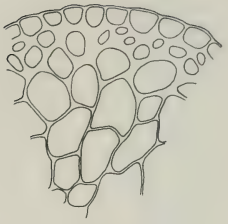

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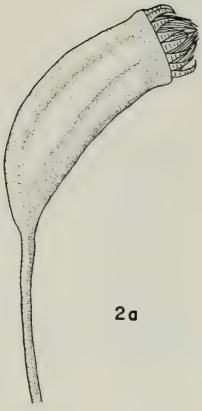

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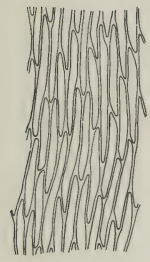

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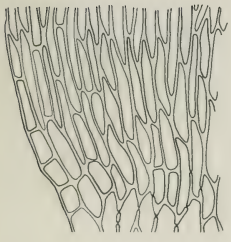

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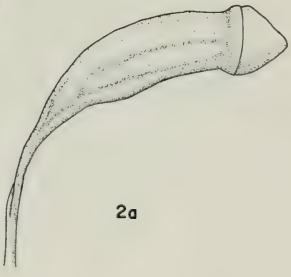

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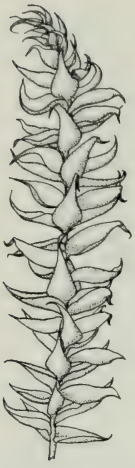

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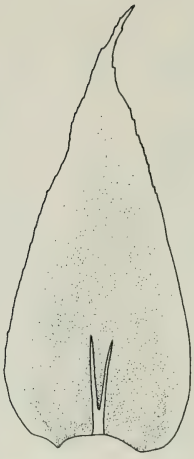

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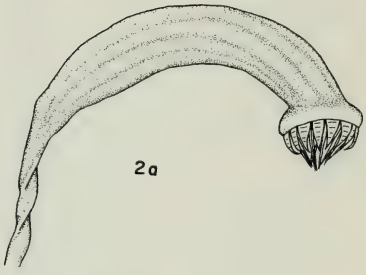

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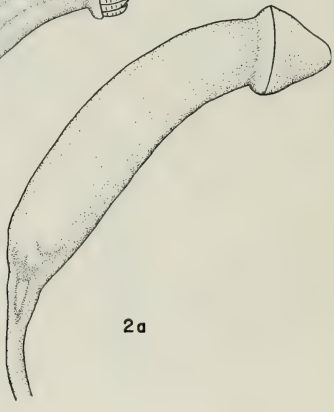

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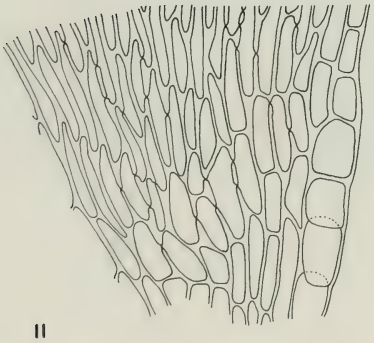

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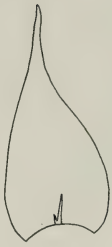

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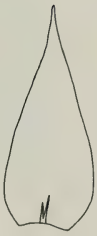

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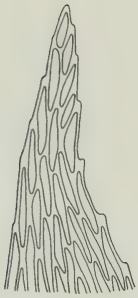

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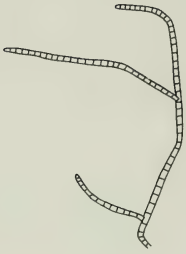

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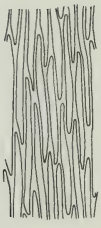

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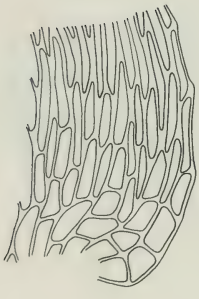

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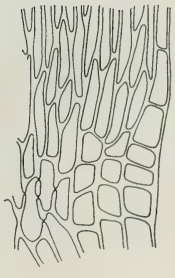

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Isopterygium tenerum

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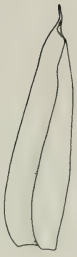

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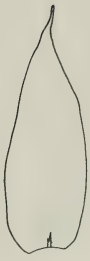

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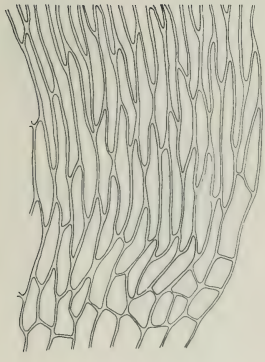

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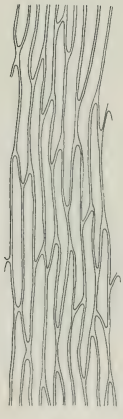

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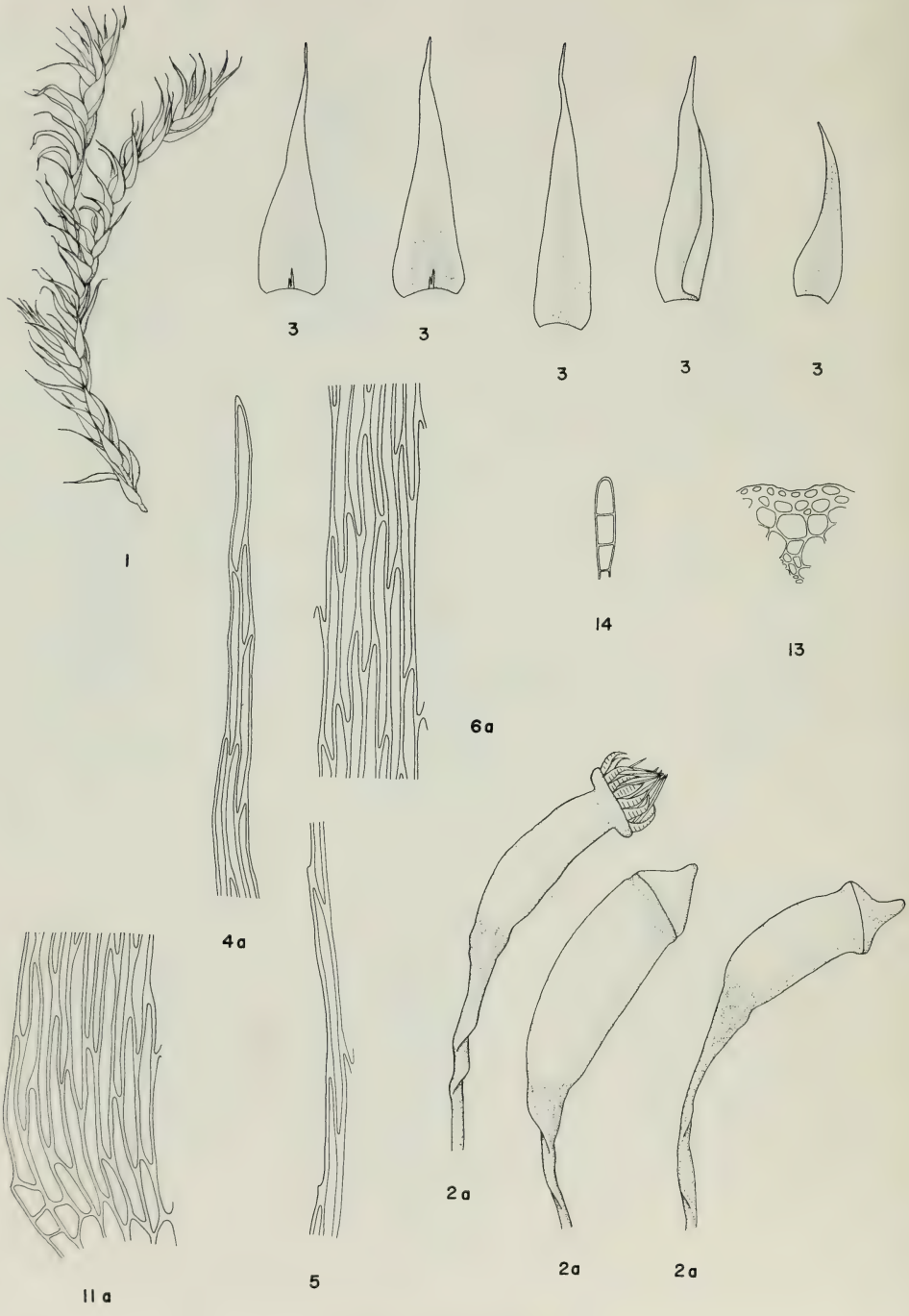
Isopterygium muellerianum



Isopterygium pulchellum

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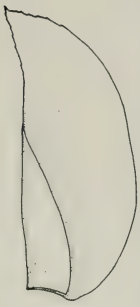

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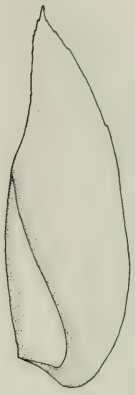

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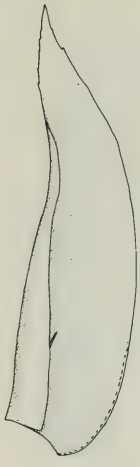

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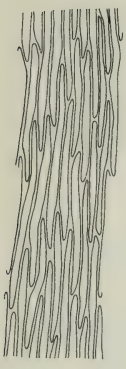

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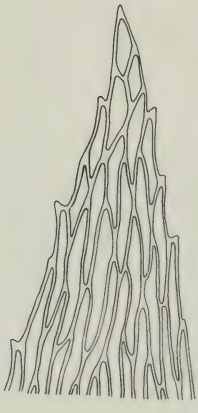

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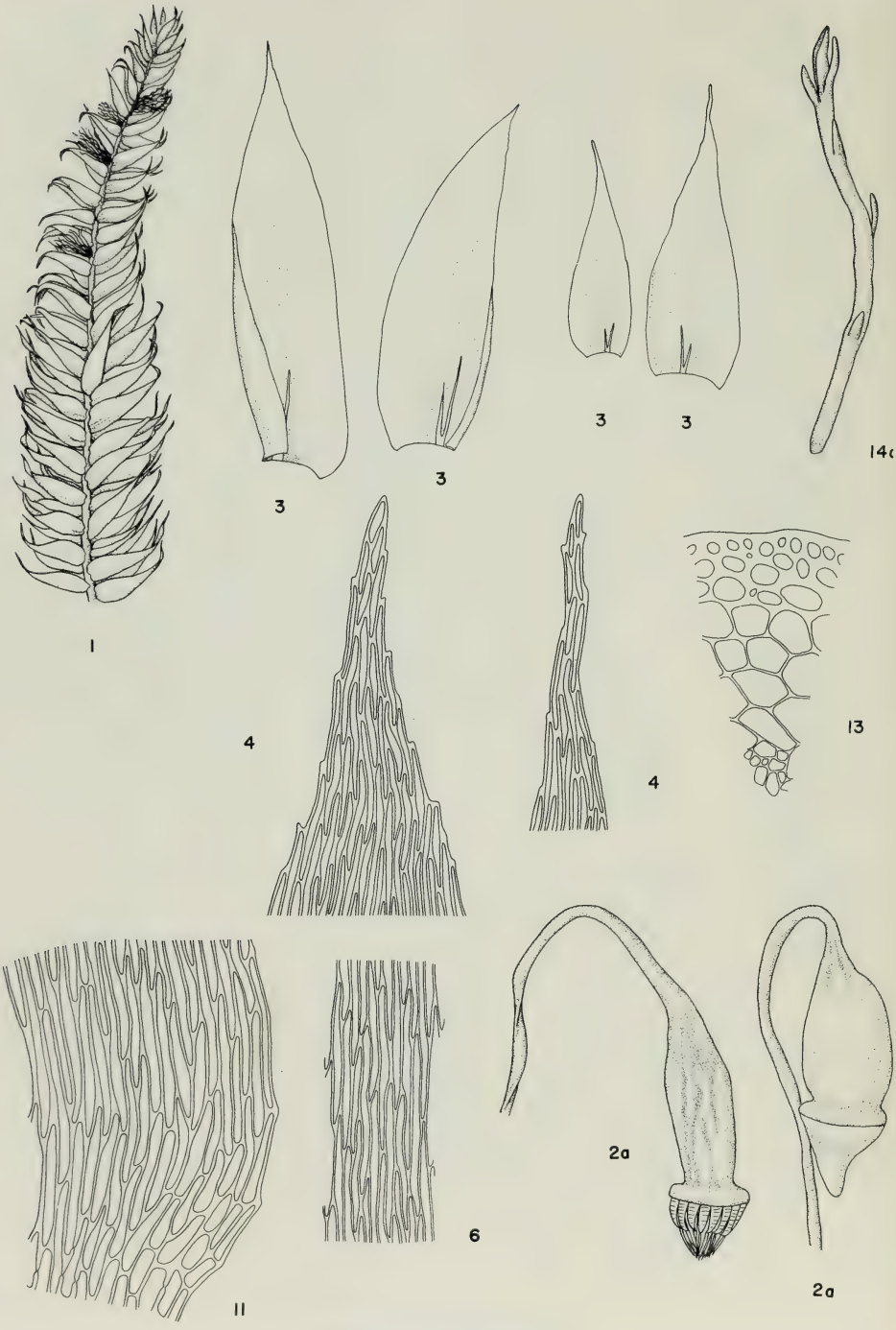
Isopterygium distichaceum



Isopterygium elegans

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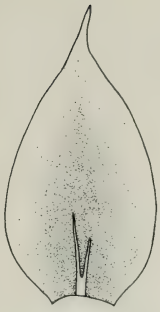

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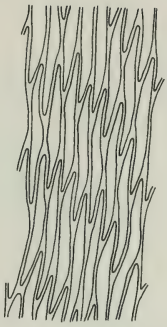

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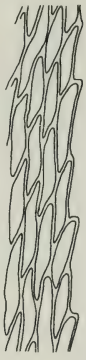

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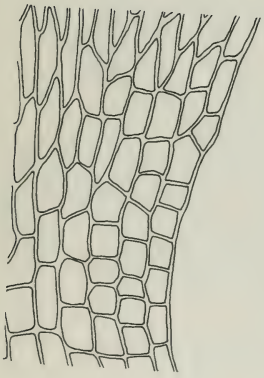

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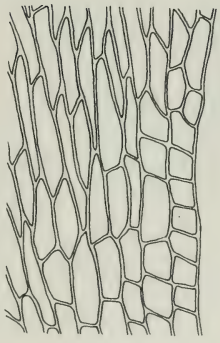

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Taxiphyllum cuspidifolium

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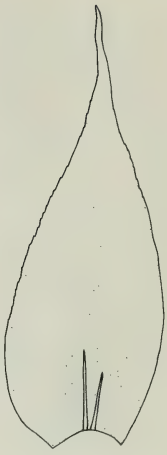

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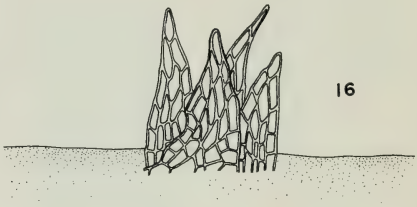

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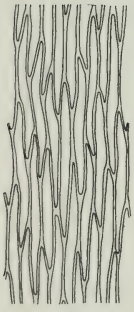

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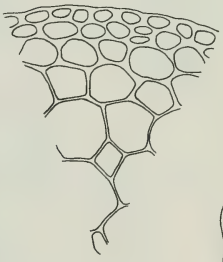

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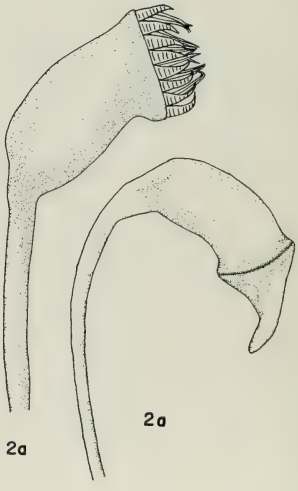

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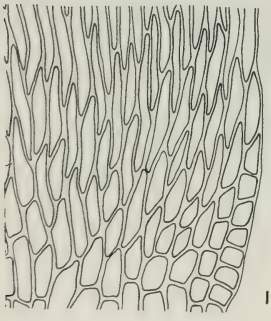

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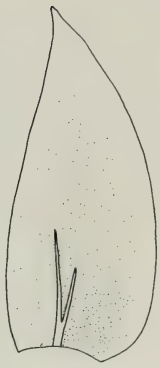
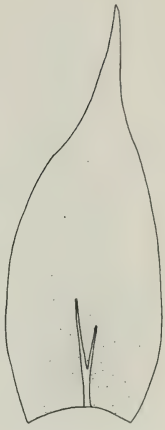
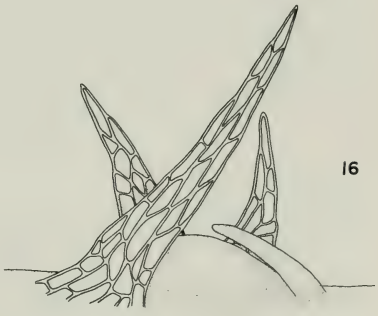
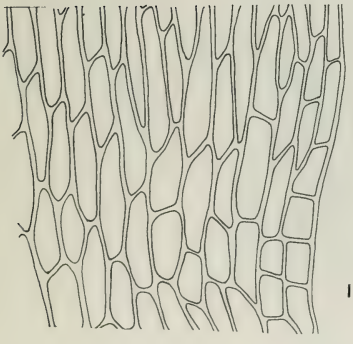
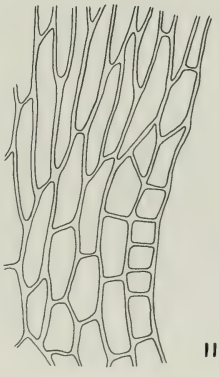
Taxiphyllum deplanatum

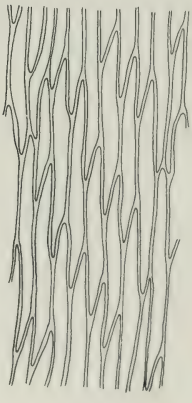




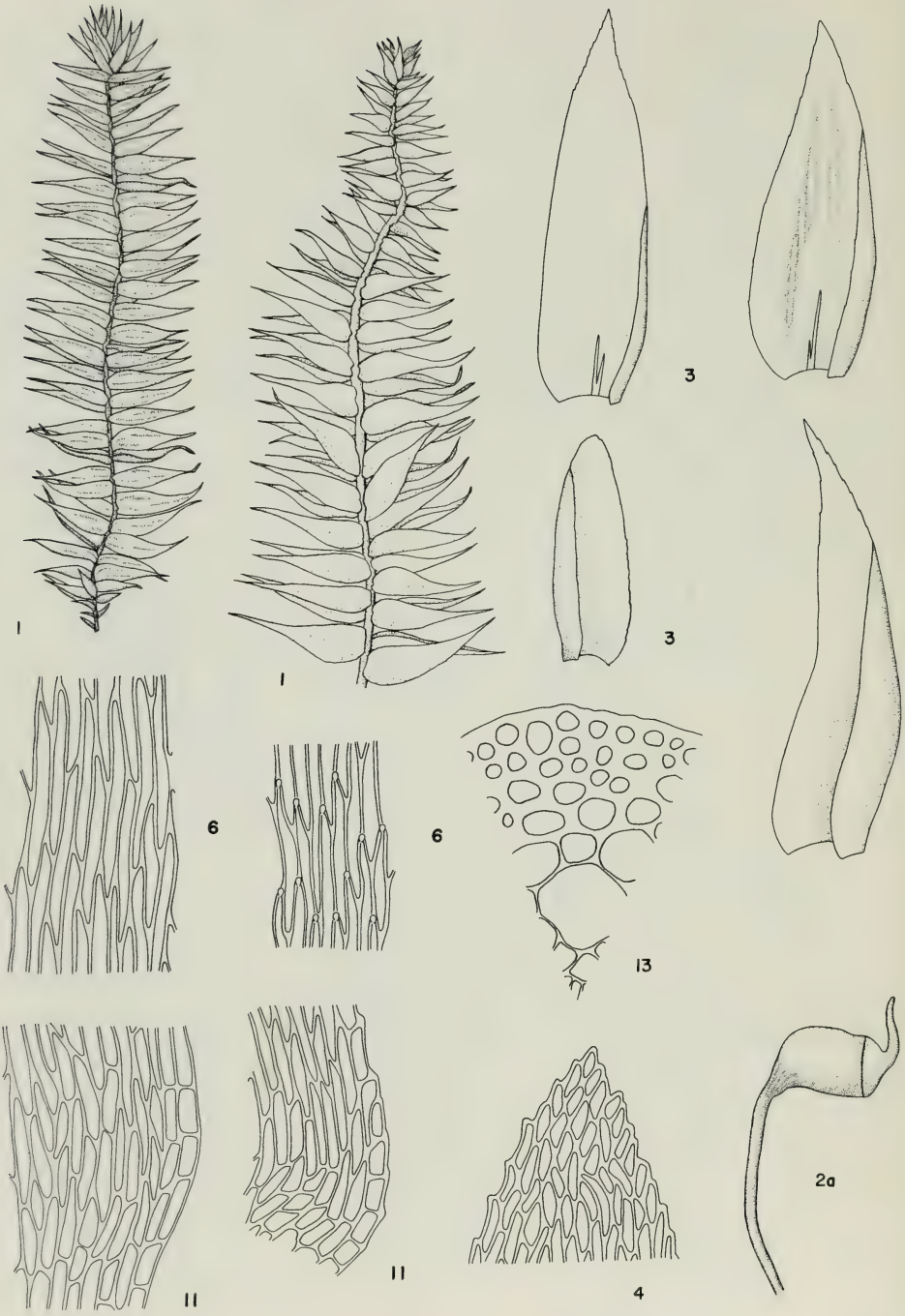








Taxiphyllum alternans



Taxiphyllum taxirameum

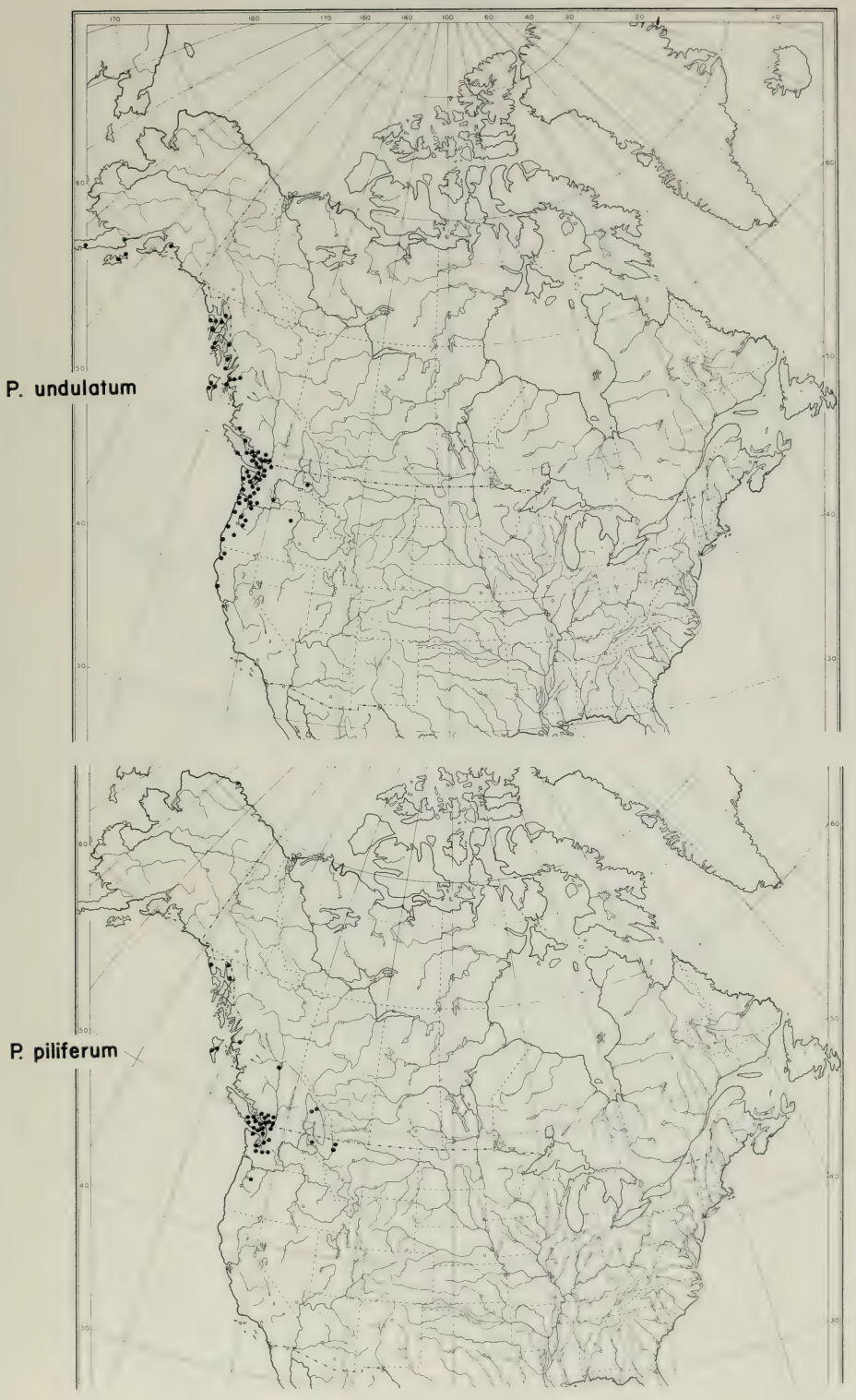
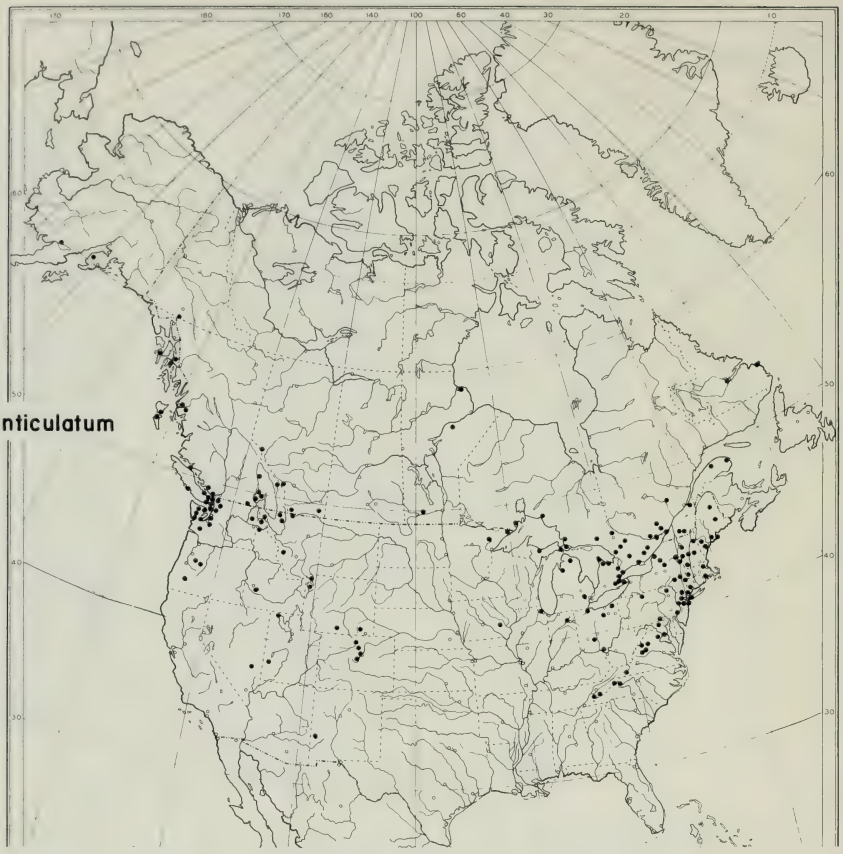


Figure 1—Distribution of *Plagiothecium undulatum* and *P. piliferum*



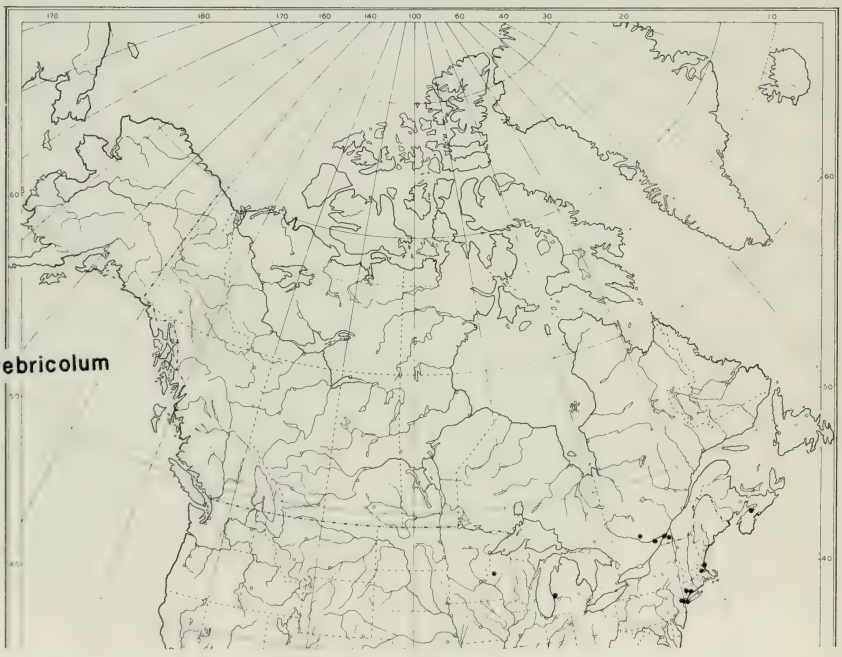


Figure 2—Distribution of *Plagiothecium denticulatum* and *P. latebricolum*

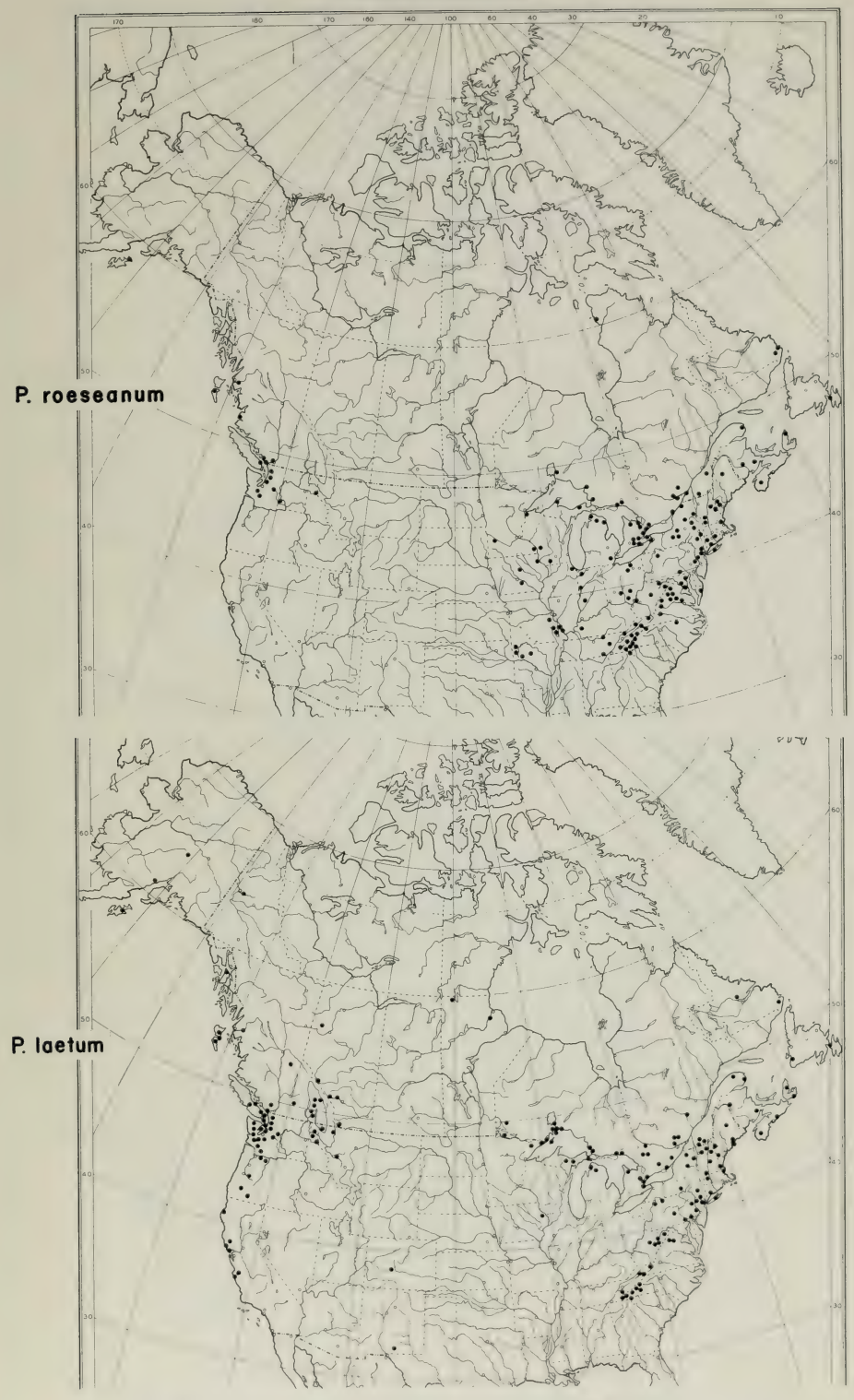
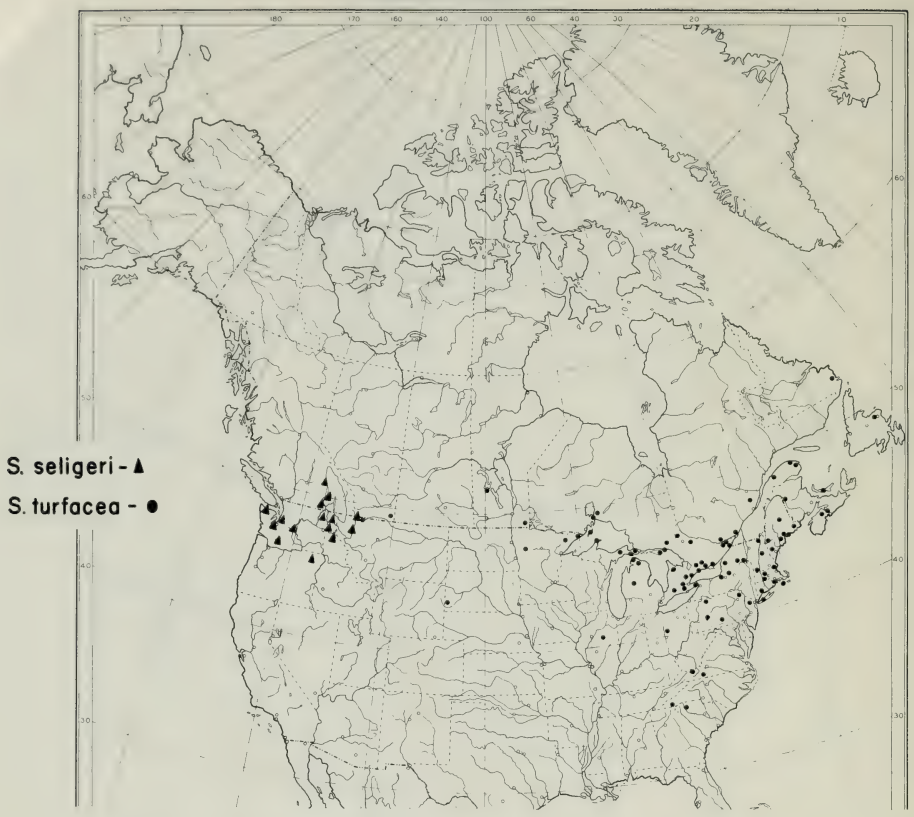


Figure 3—Distribution of *Plagiothecium roeseanum* and *P. laetum*



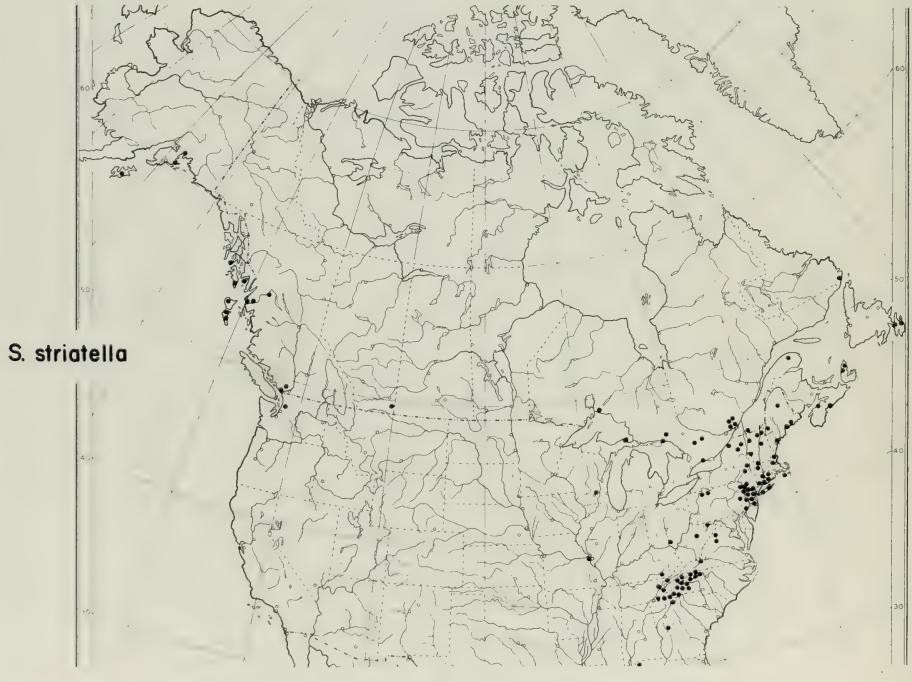
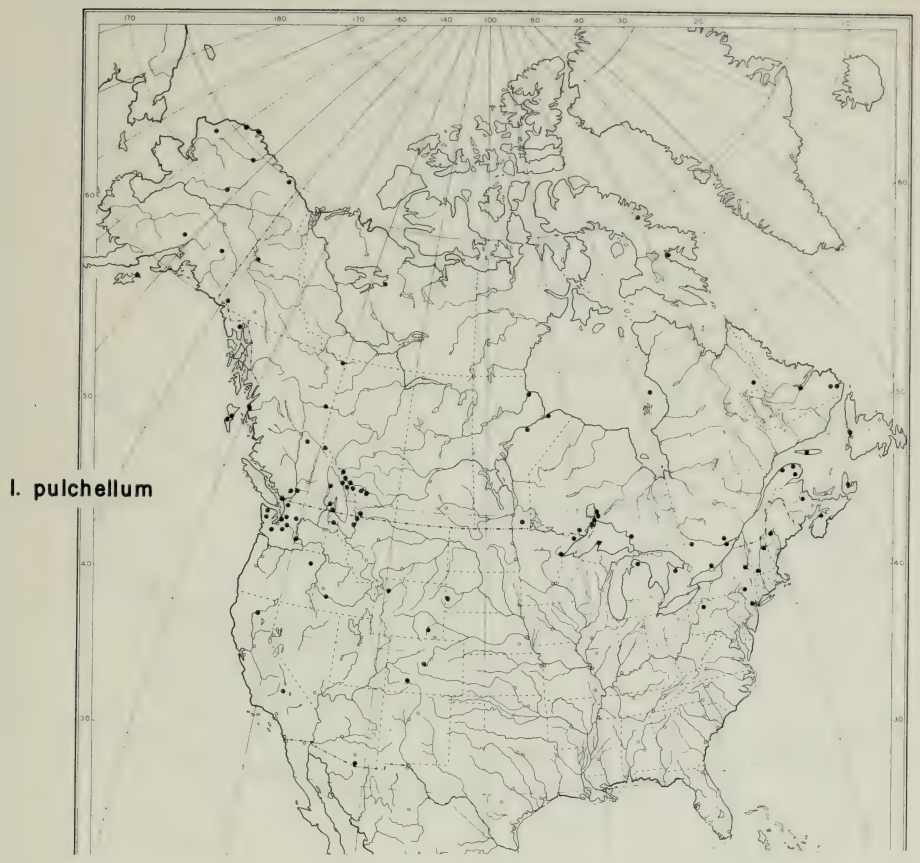


Figure 4—Distribution of *Sharpiella seligeri*, *S. turfacea*, and *S. striatella*



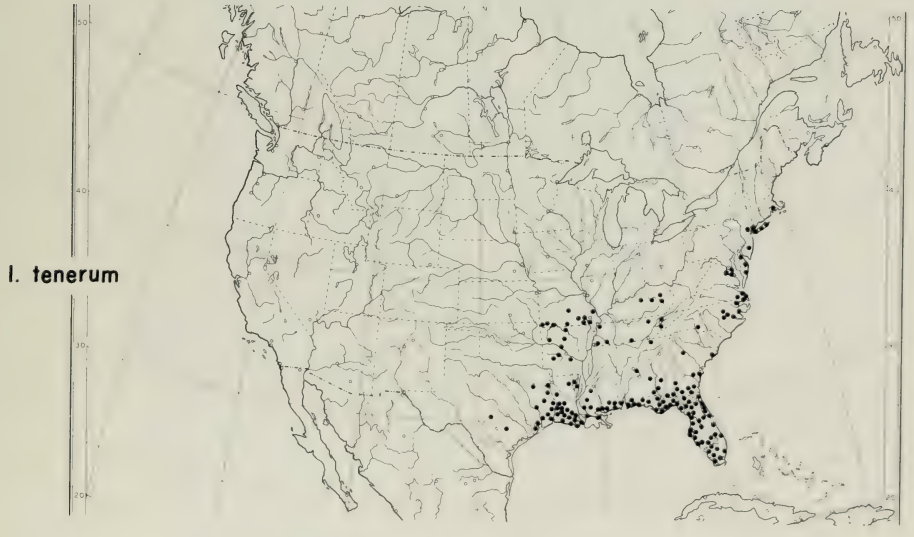
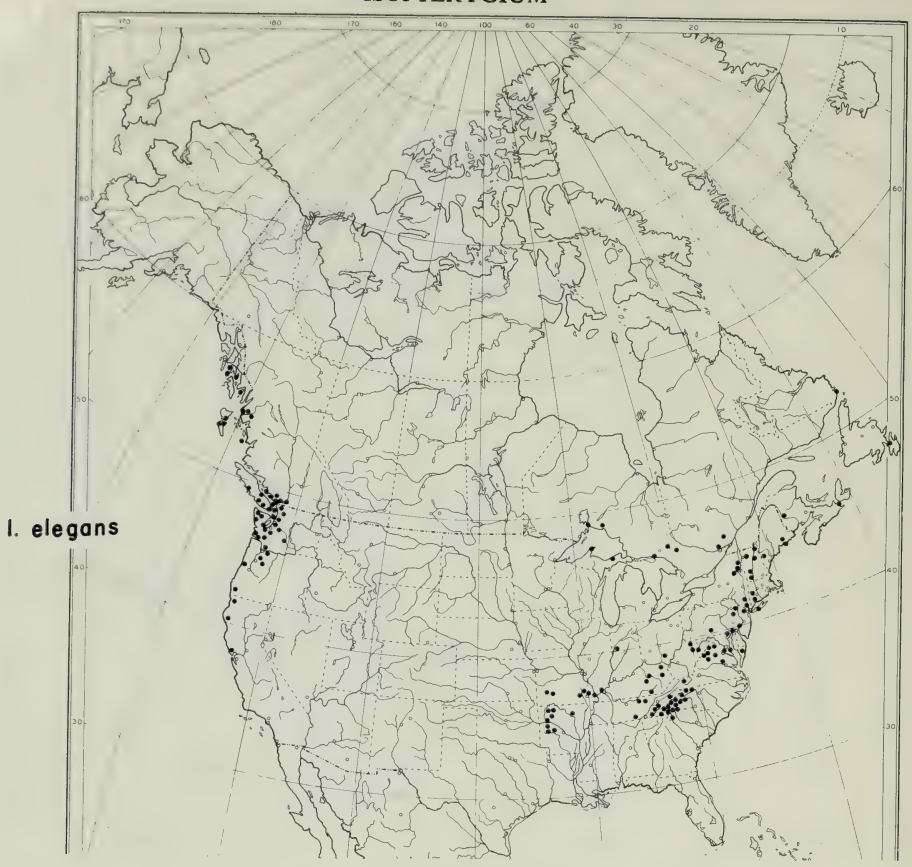


Figure 5—Distribution of *Isopterygium pulchellum* and *I. tenerum*



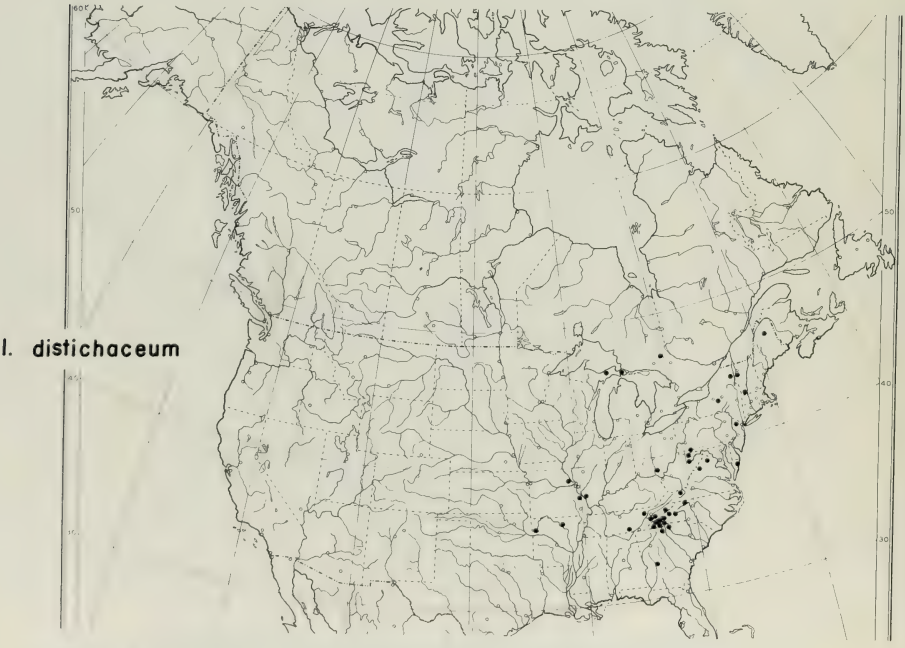


Figure 6—Distribution of *Isopterygium elegans* and *I. distichaceum*

Figure 7—Distribution of *Isopterygium muellerianum*

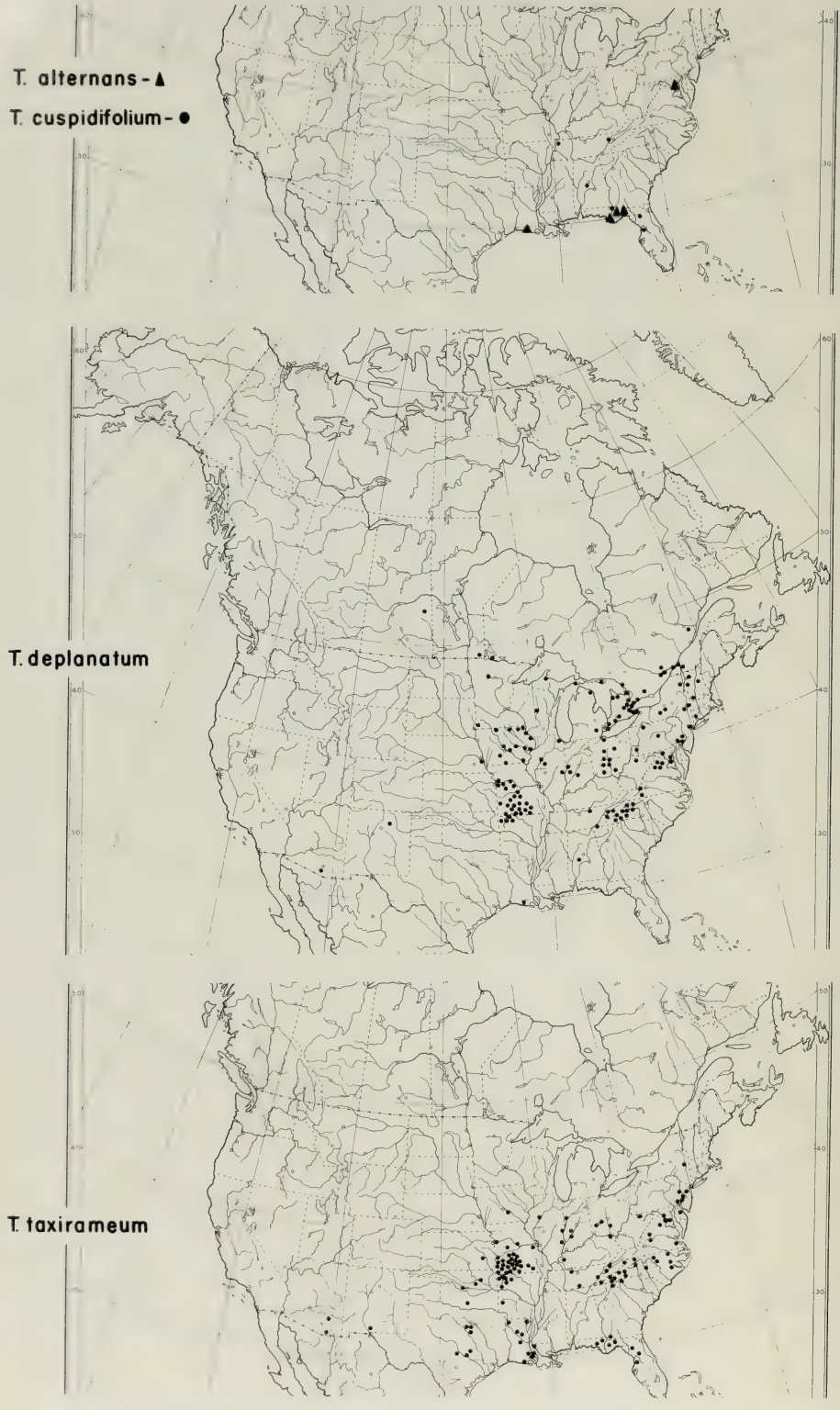


Figure 8—Distribution of *Taxiphyllum alternans*, *T. cuspidifolium*, *T. deplanatum*, and *T. taxirameum*

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